FLOOD PLAIN MANAGEMENT STUDY

BARAGA VILLAGE WATERSHED
BARAGA COUNTY, MICHIGAN

SEPTEMBER 1990

prepared by:

U.S. Department of Agriculture
Soil Conservation Service
East Lansing, Michigan

in cooperation with:

Michigan Department of Natural Resources
Baraga Village
Keweenaw Tribal Council
Baraga Township
Baraga Soil and Water Conservation District

FOREWORD

This report defines the flood characteristics of Baraga Village Watershed located in Baraga County, Michigan. Development exists within the flood plain and can be expected to increase in the future.

This cooperative report was prepared for the guidance of local officials in planning the use and regulation of the flood plain. Four potential floods are used to represent the degrees of major flooding that may occur in the future. These floods; the 10-year, 50-year, 100-year and 500-year; are defined in the report and should be given appropriate consideration in future planning for safety of development in the flood plain. Over 6.0 miles of high water profiles along the Baraga Village Drains show the expected flood elevations and water depths relative to the stream bed and flood plain. The 100-year and 500-year potential floods are defined by flood hazard area photomaps that show the approximate areas that would be flooded.

Flood hazard area photomaps and high water profiles are based on existing conditions of the watershed, stream and valley when the report was prepared.

Information in this report does not imply any federal authority to zone or regulate the use of flood plains; this is a state and local responsibility. This report provides a suitable basis for adoption of land use controls to guide flood plain development, thereby preventing intensification of flood losses.

Technical documentation for this study is on file with the Soil Conservation Service, United States Department of Agriculture, 1405 South Harrison Road, Room 101, East Lansing, Michigan 48823-5202 (telephone (517) 337-6612) and the Land and Water Management Division, Michigan Department of Natural Resources, Mason Building, P.O. Box 30028, Lansing, Michigan 48909.

Assistance and cooperation of Baraga Village, Baraga Soil and Water Conservation District, Keweenaw Tribal Council, Baraga Township, Upper Peninsula Resource Conservation and Development Council, and Michigan Department of Natural Resources in the preparation of this report are greatly appreciated.

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BARAGA COUNTY, MICHIGAN

INTRODUCTION

The flood plains of rivers, lakes and streams have been formed by nature to provide for the conveyance of flood flows resulting from large amounts of snowmelt and rainfall. Large runoff events will inundate a considerable area. Therefore, the long-term solution to reducing flood damage and loss of life is to limit development in the flood plain which could be damaged or which could obstruct the conveyance of flood waters. There are three basic actions which can be used to assure that flood plain areas are kept open to prevent damage:

1. Provide information to make lending institutions and prospective property buyers aware of the flood hazards.

2. Initiate flood plain regulations to prevent the development of the flood plain in a manner which would be hazardous during floods or restrict flood flows.

3. Acquire flood prone areas for use as parks, open space, wildlife habitat and other public uses.

Potential users of the flood plain should base their decisions upon the advantages and disadvantages of such a location. Knowledge of flood hazards is not widespread and, consequently, the managers, potential users and occupants cannot always accurately assess the risks. In order for flood plain management to be effective in the planning, development and use of flood plains, it is necessary to:

1. Develop appropriate technical information and interpretations for use in flood plain management.

2. Provide technical services to managers of flood plain property for community, recreational, industrial and agricultural uses.

3. Improve basic technical knowledge about flood hazards.

Two Michigan state laws provide the Michigan Department of Natural Resources the responsibility and the authority to regulate all development in flood plain areas.

Act 288, Public Acts of 1967, establishes minimum standards for subdividing land and for new development for residential purposes within flood plain areas. This act requires that preliminary plats be submitted to the Land and Water Management Division, Michigan Department of Natural Resources for review and determination of flood plain limits. Upon completion of review and establishment of the 100-year frequency flood plain limits, the preliminary plat may be approved and minimum building requirements specified.

Act 245, Public Acts of 1929 as amended by Act 167, Public Acts of 1968, requires that a permit be obtained from the Land and Water Management Division, Michigan Department of Natural Resources before filling or otherwise occupying the flood plain or altering any channel or watercourse in the state. The purpose of this act is to assure that the channels and the portion of the flood plain that are the floodways are not inhabited and are kept free and clear of interference or obstruction which would cause undue restriction of flood carrying capacities.

Requirements established by the Michigan Department of Natural Resources for occupation and development of flood plain areas under Acts 288 and 245 are intended to be minimum requirements only. The Michigan Department of Natural Resources urges local units of government to adopt reasonable regulations which can be used to guide and control land use and development in flood hazard areas.

The Soil Conservation Service, United States Department of Agriculture carries out flood plain management studies under the authority of Section 6 of Public Law 83-566, in response to Recommendation 9(c), "Regulations of Land Use", of House Document No. 465, 89th Congress, 2nd Session, and in compliance with Executive Order 11988, dated May 24, 1977. Flood plain management studies are carried out in accordance with Federal Level Recommendation 3 of "A Unified National Program for Flood Plain Management". The Soil Conservation Service and the Michigan Department of Natural Resources have agreed to carry out flood plain management studies in Michigan under provisions of the Joint Coordination Agreement dated September 1987. Priorities regarding location and extent of such studies in Michigan have been set in cooperation with the Michigan Department of Natural Resources.

The Baraga Soil and Water Conservation District, Baraga Village, Keweenaw Tribal Council, Baraga Township and Michigan Department of Natural Resources (Sponsors) believed that a flood plain management study was needed for Baraga Village Watershed due to urbanization and the flooding problems that have already occurred. The Sponsors have determined that there is an increasing need to properly plan for the preservation and use of the flood plain. They have indicated a need to develop technical information for the Baraga Village Watershed to develop effective management programs.

The Sponsors have adopted resolutions indicating they intend to use the technical information from the flood plain management study as a basis for adopting zoning regulations, health and building codes, subdivision control regulations and such other regulations that may be needed to preserve the environmental quality of their natural resources, and to protect the health, safety, welfare and well-being of the citizens of their communities.

A request for a flood plain management study was made by the Sponsors and a Plan of Work, dated April 1988, was agreed to by the Sponsors, along with the Soil Conservation Service. Financial contributions for this study were made by the Sponsors and the Soil Conservation Service. The Baraga Soil and Water Conservation District will assist the other Sponsors with public information dissemination.

The Sponsors provided money for aerial photography and topographic mapping for flood plain delineation and for watershed modeling purposes. They also furnished assistance to the Soil Conservation Service in gathering basic data. In addition, they also provided input to identify and select appropriate flood plain management alternatives.

The Land and Water Management Division, Michigan Department of Natural Resources provided coordination services with respect to study area discharges and hydraulics. They reviewed the technical aspects of the study and concurred with study results, as applicable, to implement various state statutes and provisions of the Federal Flood Insurance Program.

Natural flood plain values were obtained by Soil Conservation Service field personnel. Aerial photographs, soil maps and field checks were used to identify and delineate wetland areas. Topographic maps and communications with government officials were used to determine land use and development trends. Soils information was obtained from the published soil survey reports for Baraga County.

Two floods are delineated, the 100-year and the 500-year frequency events. The limits of the 100-year and 500-year floods were generally too close to delineate and are shown as the same line on the aerial photomap sheets. These floods have an average occurrence of once in the number of years as indicated; e.g. the 100-year flood occurs once in 100 years on the average. The 100-year flood has a 1 percent chance of being equaled or exceeded in any given year, and the 500-year flood has a 0.2 percent chance of being equaled or exceeded in any given year. In addition to the two floods delineated on the aerial photomaps, the 10-year flood is also shown on the high water profiles. 50-year flood elevations are also shown in Appendix C, Table 4. In addition to the 10-year, 50-year, 100-year and 500-year floods, shallow flood hazard areas are shown on the aerial photomaps. These areas are based on field observation, interviews, contour maps, field surveys and the soil survey. The flood plain management program enacted by local action is to be based on the technical results and recommendations of this report.

The Land and Water Management Division, Michigan Department of Natural Resources and the Soil Conservation Service, United States Department of Agriculture will, upon request, provide technical assistance to federal, state and local agencies and organizations in the interpretation and use of the information developed in this study. For assistance contact:

Baraga Soil and Water Conservation District
300 Dunstan Street
Hancock, Michigan 49930-2117
Telephone: (906) 482-0360

DESCRIPTION OF STUDY AREA

Watershed Area

Baraga Village Watershed is located on the Keweenaw Bay of Lake Superior in northwestern Baraga County. Baraga County is located in the western region of Michigan's Upper Peninsula (Figure 1). Baraga County is bound by Houghton County on the west, Houghton County and Lake Superior on the north, Iron County on the south and Marquette County on the east. This watershed is part of the U.S. Geological Survey Hydrologic Unit 04020105.

The Baraga Village Watershed consists of five major watersheds as follows:

Name	Drainage Area (Acres)
Center Drain	240
Diversion Drain	1,104
North Drain	265
Voss Drain	1,020
Other (Local)	557
TOTAL	3,186 acres

The drains generally flow in a southeasterly direction and outlet into the Keweenaw Bay of Lake Superior. Road ditches and restrictive culverts divert water from the northern to southern watersheds. In addition, flood waters are diverted from the upper portion of Voss Drain into Center Drain.

Baraga Village has a population of 1,055 people (1980 census) with a county population of 8,484 people. There are approximately 1,060 Keweenaw Bay Indian Tribal members in Baraga County; members generally reside within the watershed. Tribal land is located on the north side of the Village. Land ownership within the Village is approximately 74 percent private, 1 percent state, 20 percent Keweenaw Bay Tribal land and 5 percent local public land.

The Baraga Village community was established in the late 1800s and developed during the logging era in the Upper Peninsula. Today, tourism-recreation and forest products, as well as manufacturing and service industries, are the major industries for both Baraga Village and Baraga County. The recent construction of a state correctional facility on the south side of the Village will enhance the economic condition of the area and provide several additional service jobs and businesses within the area. The median household income (1979) was just over $11,900. There are approximately 575 housing units located within the Baraga Village limits. Of these 575 units, approximately 115 belong to Keweenaw Bay Indian Tribal members.

Agricultural production within the watersheds is limited. There are no cropland acres in the watershed. There are approximately 90 acres of idle grassland or hayland in the upper watershed.

US DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

VICINITY MAP

LEGEND

UNIMPROVED ROAD	STUDY REACHES
GRAVEL OR SIMILAR ROAD	WATERSHED BOUNDARY
BITUMINOUS SURFACED ROAD	NARROW STREAM
PAVED ROAD	CIVIL TOWNSHIP BOUNDARY
UNITED STATES HIGHWAY (27)	SECTION LINE
STATE HIGHWAY (13)	UNINCORPORATED COMMUNITIES
RAILROAD (ANY NUMBER TRACKS) USED BY SINGLE OPERATING CO.	INCORPORATED CITY OR VILLAGE

FIGURE 1

STUDY AREA MAP

Baraga Village

FLOOD PLAIN MANAGEMENT STUDY

BARAGA COUNTY, MICHIGAN

2400 1200 0 2400 4800

SCALE IN FEET
Approximate

BASE COMPILED FROM MICHIGAN COUNTY HIGHWAY MAP.

JUNE 1990 1006199-01

USDA SCS-NATIONAL CARTOGRAPHIC CENTER, FT WORTH, TX -1991

The major land use within the watershed is rural residential and urban land, with approximately 25-30 percent of the area in forest cover. This compares to the total land surface of the county of 576,500 acres, of which 90-93 percent are forested. Hydric soils account for approximately 19 percent of the land area in Baraga County, with less than 10 percent of the total acreage of the watershed being hydric soils. Hydrophytic vegetation present is generally along the drainage ways and, in most cases, caused by restrictive culverts and passages. Urban and residential development, in the past, has reduced the areas of hydrophytic vegetation to small areas 0.1 to 2 acres in size. With the exception of a 95 acre wetland located in the northeast portion of the watershed, most of this vegetation is in the form of shrub-brush or woody vegetation and is relatively insignificant for wildlife-wetland values due to its location and lack of contiguous size.

No rare, threatened and endangered species or state and nationally significant archaeological or historic resources are known to be found in the flood plain or local drainage ways within Baraga Village.

The topography of the Village ranges from nearly level along the lakeshore to moderately steep slopes in the upper portions of the Village. The majority of Baraga Village is located on slopes from 2 to 8 percent. Major soil types found within the Village include Au Gres sand, Abbaye loamy sand, Munising loamy sand and Skanee loamy sand, with Munising the predominate soil series found in the watershed.

The Munising series consists of very deep, moderately well drained soils. The soils have a fragipan within the lower subsoil. Permeability is moderate in the upper part of the profile and slow in the fragipan.

Limitations for Munising and the other major soil series for building site development, both with and without basements, are severe. Wetness is the major problem. The water table is perched on the fragipan in the Munising soils and is an apparent (regional) water table in the Au Gres and Skanee soils. Soil limitations for local roads and streets are moderate on the Munising soils and severe for the other major soils. The main limitations are wetness and frost action. Clay content for the major soil series in the upper 1 to 2 feet ranges from approximately 5 to 18 percent.

The average annual temperature is 40°F. The average annual precipitation is 37.0 inches. Of this, 18.93 inches, or 64 percent, usually falls in April through September, which includes the growing season for most crops. The average annual snowfall is 137.0 inches.

Study Area Flood Plain

The study area is in Baraga County, Michigan. High water profiles and flood plain delineations were made along the Baraga Village Drains for a distance of about 6.0 miles. The study area is identified in Figure 1.

FLOOD PROBLEMS

The major natural resource related problem found within Baraga Village is a severe surface water flooding and erosion problem. Annual surface water flooding results in damage to homes, streets and businesses; erosion damage; and water quality damage; as well as social and economic damage to the Village and surrounding community.

Baraga Village, like many rural western Upper Peninsula communities, developed because of the natural resource economic base found in the area. Baraga is located at one of the sites of the lumber mills and transportation centers of Keweenaw Bay. Once established, the community's future development plans did not always take into account the natural landscape limitations or plans for future development. As development occurred over time, potential downstream or surface water flooding, erosion and water quality problems were not addressed. Development of concentrated housing units by the Village in the mid-1960s, and more recently on Keweenaw Bay tribal land, intensified the runoff problems. Recent housing and business development has restricted drainage ways.

Local officials and developers are continuing to propose development in the upper watershed. This new development will cause increased runoff damage to the Village's business, residential and tribal housing areas. The Ojibwa Casino, Ojibwa housing development, Connors lumber yard and mill, and the industrial park have increased the volume of runoff in the last few years. Development associated with the state correctional facility has the potential to magnify the possible flood, environmental, safety and health problems of the Village.

Recent developments have already had an impact on the area. Engineering and architectural plans are underway for new housing units within the Village that would increase the Village population by nearly 20 percent within the next year. The population projection for 1990 is estimated to be 1,543, which is nearly a 50 percent increase in population within the past ten years. Also, several new businesses are planned or under construction within the low area along the west side of US-41.

Current storm water facilities in the Village are able to adequately contain only a small percentage of the potential runoff. Normal storm runoff pushes culverts and drainage ways to their limits. The existing drainage and water courses are not able to handle high intensity, short duration storms that frequent the region.

Past high intensity, short duration storms caused well contamination and streets to be washed out (Keweenaw and Main Streets), necessitating sewer line repairs and replacement. Following a 1968 storm, state and federal agencies declared Baraga County a disaster area. Special funds of over $500,000 were spent in the county for repair and replacement for sewer and roads. Individual landowners spent several hundred dollars each for repairs to yards because of the gullying and erosion caused by these storms. Water used for drinking had to be boiled because of contamination caused by the 1968 storm.

Other problems identified from storm runoff include water damage to homes, businesses, utilities and roads. Homeowners have, in the past, been cut off by storm water and unable to leave their homes due to water velocities and depths. Some of the local people work in the city of L'Anse, which is located three miles from Baraga. US-41 is the only available road between Baraga and L'Anse. When this road is overtopped and unpassable, people of Baraga who work in L'Anse cannot get to their jobs, causing a loss in wages. The nearest hospital serving the Village is also in L'Anse. Hospital services are unavailable during high flood flows and the next nearest hospital is located 30 miles away in Hancock, Michigan. Storm events posed a safety hazard for small children and senior citizens when drainage channels are filled and parking lots are flooded. Flooding causes standing water to affect more than 50 properties in the tribal housing development area. This has been a nuisance, as well as a health and safety hazard. Flooding prevents emergency vehicles located in L'Anse and Baraga from servicing Baraga Village, should the need arise.

The 100-year flood would inundate approximately 328 acres of land. Approximately 187 homes and businesses would experience flooding during a 100-year flood. Many of the road crossings in the Baraga Village Watershed would be impassable in the event of a 100-year flood.

In addition, many side streets would be inundated with shallow flows approximately 0.5 to 1.0 foot deep.

This study provides high water profiles and areas subject to flooding based on analyses of existing stream hydraulics and current watershed and flood plain conditions. Water surface profiles along the study reaches are shown for the 10-year, 100-year and 500-year flood events. Elevations for the 10-year, 50-year, 100-year and 500-year floods are shown in Appendix C, Table 4. The approximate areas of inundation for 2 floods, the 100-year and 500-year, are shown on the aerial photomaps.

Shallow flood hazard areas based on field observations, interviews, contour maps and field surveys are also shown on the aerial photomaps.

There are some areas that are flood prone because of high water table conditions that are not shown in this report. These flood prone areas are identified in the soil survey report for Baraga County.

Typical valley sections shown in Appendix B indicate the effects of the four floods. Flood discharges used for computing high water profiles in the study area are shown in Appendix C, Table 3. Appendix C, Table 4 shows flood elevations at each of the valley sections for present conditions.

While no computations were made to reflect the problems of ice and debris blockage at bridges, because of the wide possible variations in conditions, a few generalized comments can be made. Ice and debris can ocassionally totally block an opening. To determine possible effects, refer to the high water profile sheets. At each bridge or culvert, a "low point or road overflow" symbol is shown. Based on field surveys, this is the elevation at which the road would flood. If there is no culvert capacity available, all flows would need to go over the road through this low section. The depth of flow and flooding would depend on the quantity of flow, as well as cross-sectional area available for flow.

TABLE 1 - DEPTH OF FLOW OVER LOW POINT IN ROAD

Road Name	100-Year Flood (Depth in Feet)	50-Year Flood (Depth in Feet)	10-Year Flood (Depth in Feet)
Diversion Drain			
McGillan	0.8	0.5	0.0
Spruce	0.0	0.0	0.0
Lyons	0.0	0.0	0.0
Main	1.2	1.1	1.0
North Drain			
McGillan	0.4	0.3	0.1
Lyons	0.8	0.7	0.5
Main	0.7	0.4	0.0
Superior	*	*	*
M-38	*	*	*
Center Drain			
Bear Town	*	*	*
M-38	1.0	0.8	0.0
McGillan	0.9	0.8	0.0
Lyons	*	*	*
Superior	*	*	*
Voss Drain			
Superior	0.4	0.3	0.0
US-41	0.2	0.0	0.0

* Approximate flood hazard area, depth of flow varies from 0.5 to 1.0 foot.

DETERMINATION OF FLOOD HAZARD FOR SPECIFIC LOCATION

To determine flood levels for a specific location, locate the area of concern on the sheet index, Appendix A, Figure 2. Select the appropriate flood hazard photomap. Using this photomap, locate the area of concern on the map and its relationship to the nearest identification point (cross-section, road).

If the specific location is outside the flood hazard boundaries, there is no apparent flood hazard from the Baraga Village Watershed Drains unless the area is subject to high water table conditions (see soil survey report for Baraga County).

For those areas within the flood hazard boundaries, refer to the adjacent high water profile and locate the area of concern on the profile. The mean sea level flood elevation, Baraga datum, can then be determined for the appropriate flood event. Appendix C, Table 4 shows flood elevations at each cross-section.

Those areas identified as shallow flood hazard areas can expect flood depths in the range of 0.5 to 1.0 foot. There may be small, localized portions upstream of road fills where water ponds with depths approaching 6 feet.

EXISTING FLOOD PLAIN MANAGEMENT

Currently, Baraga Township has no existing flood plain ordinances or flood insurance. Baraga Village has a Flood Insurance Rate Map, dated August 4, 1988, Community No. 260551. The Village also has a Flood Plain Ordinance #127, dated November 9, 1981. The flood plain management study will provide the information needed to update this existing ordinance. In addition, the Building Officials and Code Administrators' (BOCA) National Building Code, enforced in both the Township and the Village, requires that the lowest horizontal structural member be at or above the 100-year flood plain elevation. The flood plain management study will provide the information needed to enforce the existing building code.

ALTERNATIVES FOR FLOOD PLAIN MANAGEMENT

The objectives of flood plain management are to reduce the damaging effects of floods, preserve and enhance natural values and provide for optimal use of land and water resources within the flood plain. Flood plain management can minimize potential flood damages by:

1. Prohibiting uses which are dangerous to public health or safety in times of flood.

2. Restricting building or other development which may cause increased flood heights or velocities.

3. Requiring that public or private facilities that are vulnerable to floods be protected against flood damage at the time of construction.

4. Protecting individuals from investments in flood hazard areas which are unsuited for their intended purposes.

5. Providing information on flood proofing techniques for existing structures in the flood plain.

There are numerous flood plain management alternative categories and tools that can be employed to accomplish the above objectives and goals. The ones that apply to this area are suggested below. Other flood plain management techniques should be considered and may well prove to be effective in reducing or preventing flood damages. Many of the road crossings should be enlarged when replacement is necessary.

Present Condition

This is the "no change" alternative, which reflects ongoing flood plain development pressures and management trends. Local governmental units can continue to plan, zone and accept or reject requests for alternative flood plain and adjacent land uses. Flood problems may continue to increase if development continues.

Land Treatment

This alternative discusses opportunities to minimize or decrease changes in upland runoff and erosion because of land use changes. The traditional approach of accelerating conservation land treatment, by working with landowners to install conservation practices, will minimize soil erosion and reduce runoff. Installation of such measures as tree planting, windbreaks, forest management, permanent vegetative cover and on-site water storage will all reduce runoff, erosion and sedimentation.

As rural areas urbanize, the increase in peak discharges due to more efficient conveyance paths and increased impervious areas can have a significant adverse impact on downstream areas. There is growing interest on the part of planners, developers and the public in protecting downstream areas from induced flood damages that may accompany increased peaks and stages. Planning authorities are proposing local ordinances that restrict the type of development permitted and the impact development can have on the watershed. One of the primary controls that could be imposed is that future-condition discharges cannot exceed present-condition discharges at some predetermined frequency of occurrence at specified points on the channel.

Methods to control runoff in urbanizing areas can reduce the volume of runoff, the rate of runoff or both. The effectiveness of any control method depends on the available storage, the outflow rate and the inflow rate. Because a great variety of methods can be used to control peak flows, each method proposed should be evaluated for its effectiveness in the given area.

Preservation and Restoration of Natural Values

It is recommended that several selected open space areas be preserved, especially in the undeveloped areas. Their preservation, in accordance with soil limitations and good land use management, will reduce development hazards, prevent additional future flood damages and enhance the urban environment.

Restoration of wetlands can reduce downstream flooding, improve water quality and improve wildlife habitat.

1. Preserve Wetlands - Soils with high water tables should be retained in natural vegetation. No commercial or residential construction should take place on these soils since the limitations are severe. Soils information was obtained from the published soil survey report for Baraga County. Copies of the soil survey, including maps and interpretations, are available for reference at the Baraga Soil and Water Conservation District Office located at 300 Dunstan Street, Hancock, Michigan 49930-2117. This information can be used to locate the kinds of soils in a given area and evaluate their limitations for various uses. The most valuable wetland consists of 95 acres and is located in the northeast portion of the watershed. This wetland is a very effective flood storage area and reduces the peak flow under Industrial Road.

2. Preserve Open Space - Upland open space should be retained in the natural state as much as possible.

3. Preserve Woodlands - Wooded areas on steep slopes should be preserved from all development. Destruction of natural cover on these steep slopes usually causes excessive erosion during construction. Preservation of these wooded sites would also enhance housing developments in the area.

4. Promote Wildlife Areas and Outdoor Classrooms - Undeveloped flood plain areas should be managed for wildlife and recreation. These areas have potential for an excellent outdoor classroom.

Non-Structural Measures

1. Develop and implement, or update, a flood plain protection and zoning ordinance based on the 100-year frequency high water profile and the flood plain delineations, Appendix A. Retaining the storage in the existing flood plain area will be necessary if this flood profile is to remain valid. Reducing the storage capacity in the system will tend to increase elevations and discharges above that indicated in this report.

2. Flood proof buildings and residences already in the flood plain to reduce flood damages. Some basement windows and doors, floor drains and foundations can be modified to reduce effects of flood waters. Materials and supplies stored in vulnerable positions can be relocated and protected. These modifications can be planned and installed where it is desirable and/or feasible to continue using facilities currently in the flood plain.

3. Plans should be developed for alternate routes for automobile, truck and emergency vehicle traffic around those roads that will be inundated during the flood. This will require cooperation between city, township, county and state officials.

4. Maintenance of the Baraga Village Drains is very important. Debris, fallen trees and brush should be removed at least yearly. Snow and ice from road clearing operations should not be piled in the flood plain.

5. Owners and occupants of all types of buildings and mobile homes should obtain flood insurance coverage for the structure and contents, especially if located within or adjacent to the delineated flood hazard areas. The Sponsors should make necessary applications and pass needed resolutions and zoning ordinances to qualify for subsidized federal flood insurance. Contact the Land and Water Management Division, Michigan Department of Natural Resources, Mason Building, P.O. Box 30028, Lansing, Michigan 48909 for additional information.

6. Provide On-Site Floodwater Storage - Developing areas should provide on-site flood water storage to temporarily store additional runoff volumes and peak flows created by their urbanization.

TABLE 2 - MEASURES FOR REDUCING AND DELAYING URBAN STORM RUNOFF

Area	Reducing Runoff	Delaying Runoff
Parking Lots	1. Porous pavement a. Gravel parking lots b. Porous or punctured asphalt 2. Concrete vaults and cisterns beneath parking lots in high value areas 3. Vegetated ponding areas around parking lots 4. Gravel trenches	1. Grassy strips on parking lots 2. Grassed waterways draining parking lot 3. Ponding and detention measure for impervious areas a. Rippled pavement b. Depressions c. Basins
Residential	1. Cisterns for individual homes or groups of homes 2. Gravel driveways (porous) 3. Contoured landscape 4. Groundwater recharge a. Perforated pipe b. Gravel (sand) c. Trench d. Porous pipe e. Dry wells 5. Vegetated depressions	1. Reservoir or detention basin 2. Planting a high delaying grass (high roughness) 3. Gravel driveways 4. Grassy gutters or channels 5. Increased length of travel of runoff by means of gutters or diversions

Structural Measures

The sponsors are applying for assistance to construct structural measures to reduce flooding through the PL-566 Watershed Protection and Flood Prevention Act.

Six alternatives were considered in the July 1990 Preauthorization Report. They are as follows:

ALTERNATIVE 1: No Action With Continued Development

The no action alternative will allow the present flooding and erosion problems to continue and get worse as time progresses. Present and expected future development will increase the impervious area within the watershed. This will cause increased runoff volumes and flow rates and the associated problems of flooding, erosion, water quality impairment and damage to homes, businesses and roads. Flooding of state and federal highways would continue. Channel erosion within the existing drainage ways would increase due to greater flood flows, causing additional sediment deposition and water quality impairment in Keweenaw Bay. No action with continued development within the watershed will allow 187 homes and businesses to be flooded by the 100-year flood.

ALTERNATIVE 2: Required On-Site Detention of 100-Year Flood for all Future Development

Components

Alternative 2 consists of working with Baraga Village, Baraga Township and the Keweenaw Tribal Council to enact an ordinance that would require all new development to provide facilities for detention of runoff expected from the 100-year, 10-year and 2-year floods. It would require that runoff leave the developed site at a rate no greater than that for the presently existing undeveloped condition.

Costs will be incurred primarily by developers and home builders who will pass the cost on to future homeowners.

Effects

Enactment of such an ordinance would prevent flooding and erosion problems from increasing. Alone, however, it will allow the present flooding and erosion and sedimentation problems to continue unchecked. Development to date has progressed beyond the capacity of the existing drainage courses and structures. Alternative 2 will allow 187 homes and businesses to be flooded by the 100-year flood. This is a 24 percent reduction over Alternative 1. This reduction is due to shallower flood depths.

ALTERNATIVE 3: Diversion Channel and Required On-Site Detention of 100-Year Flood for all Future Development

Components

Alternative 3 consists of the Village/Township/Tribal Council ordinance component of Alternative 2 and one flood water diversion channel. The diversion channel will provide flood damage reduction to Baraga Village by diverting water from the "Center Drain" at Bear Town Road, from the "North Drain" at McGillan Street and from the "Diversion Drain" at Spruce Street. Also, flood damage reduction will be provided to the Indian Village which is bisected by the "Diversion Drain", whose channel is presently not adequate to carry the 100-year flood. The diversion channel watershed will consist of the "Center Drain" watershed (162 acres) west of Bear Town Road, the "North Drain" watershed (236 acres) west of McGillan Street and the "Diversion Drain" watershed (1,014 acres) at Spruce Street for a total of 1,412 acres. The diversion drain will carry the runoff expected from this watershed for the 100-year flood, with detention requirements met on all new development within the watershed. It will be aproximately 1.7 miles in length with 5 grade stabilization structures consisting of precast, reinforced concrete box culverts. The reach from Bear Town Road to McGillan Street will be grassed waterway with gabion-lined center. The reach from McGillan Street to Lyons Street will be grassed waterway. The reach from Lyons Street to the outlet will be gabion-lined channel with a plunge pool at the outlet. The flood waters will be discharged into a 95-acre wetland that will attenuate the flood waters such that no improvements will be required for the existing channel between that wetland and the eventual outlet in Keweenaw Bay. Sixteen side inlet structures will be included along the diversion channel to allow water from points of concentrated flow to safely enter the diversion channel. Portions of the diversion channel will be constructed by diking with earth fill. Failure of these diked portions would result in damage to homes and businesses. Therefore, these dikes are designated as Class I.

Effects

Installation of Alternative 3 will allow 131 homes and businesses to be flooded by the 100-year flood. This is a flood damage reduction of 36 percent over Alternative 1.

Installation of the diversion channel will temporarily disturb terrestrial habitat along the channel route. Also, a small area of wetland will be disturbed by installation of the plunge pool at the diversion outlet. However, the plunge pool will have no long-term adverse effects on the wetland. Woody vegetation will be removed from the construction site and replaced with grasses. Also, the plunge pool will create a permanent pool that will be beneficial to local wildlife.

ALTERNATIVE 4: Replacement of Most Center Drain Road Crossings and One North Drain Road Crossing, Reconstruction of a Portion of the North Drain, Construction of a Diversion Channel and Required On-Site Detention of 100-Year Flood for all Future Development

Components

Alternative 4 consists of the Village/Township/Tribal Council ordinance component of Alternative 2, the diversion channel component of Alternative 3 and the following components:

1. Center Drain Structures:

    a. CS 42.0 - 340 linear feet (LF) of 4' x 8' reinforced concrete (R/C) box culvert with headwalls on both ends, under railroad grade and Superior Avenue.

    b. CS 44.0 - 410 LF of 4' x 8' R/C box culvert with headwalls on both ends, under school parking lot.

    c. CS 46.0 - 80 LF of 4' x 8' R/C box culvert with headwalls on both ends, under McGillan Street.

    d. CS-47.0 - 30 LF 4' x 8' R/C box culvert with headwalls on both ends, under driveway (first driveway west of McGillan Street, south side of M-38).

    e. CS 48.0 - 30 LF 4' x 8' R/C box culvert with headwalls on both ends, under driveway (second driveway west of McGillan Street, south side of M-38).

    f. CS 49.0 - 100 LF 4' x 8' R/C box culvert with headwalls on both ends, under M-38.

2. North Drain Structures and Channel Reconstruction:

    a. CS 72.0 - 40 LF 6' x 8' R/C box culvert with headwalls on both ends, under Lyons Street.

    b. Reconstruct 500 LF of channel from 230' upstream to 270' downstream of Lyons Street crossing (station 107+50 to station 102+50) and install gabion chute grade stabilization structure at station 102+50, located 230' upstream of Lyons Street.

Effects

Installation of Alternative 4 will give the benefits of Alternative 2 and 3 in addition to the benefits of providing adequate capacity to the Center Drain and North Drain road crossings downstream from the diversion channel. The planned improvements will provide capacity adequate to carry the runoff expected for the 100-year flood from the watershed below the diversion channel without flooding local homes and businesses.

Installation of the Alternative 4 will allow 17 homes and businesses to be flooded by the 100-year flood. This is a flood damage reduction of 86 percent over Alternative 1.

ALTERNATIVE 5: Multiple Flood and Erosion Reduction Projects in Baraga Village, and Required On-Site Detention of 100-Year Flood for all Future Development (Recommended Plan)

Components

Alternative 5 consists of the Village/Township/Tribal Council ordinance component of Alternative 2, and the following components:

1. Voss Drain Road Crossing Replacements:

    a. CS 22.0 - 54 LF of 6' x 8' R/C box culvert with headwalls on both ends, under Superior Avenue.

    b. CS 23.0 - 20 LF of 6' x 8' R/C box culvert with headwalls on both ends, under crossing just west of Superior Avenue.

    c. Replace the existing 36" dia. R/C pipe at the M-38 road crossing over Voss Drain with a 4' x 8' R/C box culvert.

2. Voss Drain Channel Reconstruction:

    a. Reconstruct 6230 LF of channel from the railroad grade (station 108+40) to M-38 with gabion baskets.

    b. Install gabion chute grade stabilization structure approximately 80' upstream of Superior Avenue (station 100+25).

3. North Drain Road Crossing Replacements and Channel Reconstruction:

    a. CS 72.0 - 40 LF 6' x 8' R/C box culvert with headwalls on both ends, under Lyons Street.

    b. Reconstruct 500 LF of channel from 230' upstream to 270' downstream of Lyons Street crossing (station 107+50 to station 102+50) and install a gabion chute grade stabilization structure approximately 230' upstream of Lyons Street (station 102+50).

4. Center Drain Long Underground Conduit Replacement:

    CS 42.0 - 340 LF of 4' x 8' R/C box culvert with headwalls on both ends, under railroad grade and Superior Avenue.

5. Dike above FHA Retirement Home on Center Drain.

6. Install additional 4' x 5' R/C box culvert under US-41.

7. Surface drainage projects in the Ojibwa housing area.

Effects

Installation of Alternative 5 will give most of the benefits of Alternative 4 in addition to the added benefits of providing stability and adequate capacity to the Voss Drain. The planned improvements will provide capacity adequate to carry the runoff expected for the 100-year flood from the entire Voss Drain watershed, including Sub-Area #5 (Voss Drain Watershed north of M-38), without flooding of local homes and businesses. The 36" diameter culvert presently at the M-38 crossing over Voss Drain is inadequate to carry the expected discharge from the 100-year flood. Flow in excess of the culvert capacity floods over M-38 at Bear Town Road, runs downhill on and along M-38, then enters the Center Drain above its M-38 crossing, west of McGillan Street. This results in flooding of the senior citizens housing located at McGillan Street and the school parking lot further downstream.

Flooding of a few roads and drive crossings, along with the school parking lot will still occur along the Center Drain; however, installation of a dike or curb above the retirement housing and the long underground conduit at CS 42.0 between Superior Avenue and the railroad grades will eliminate most damages. Also, flooding of M-38 will continue at the outlet of the North Drain between Main Street and US-41.

Installation of Item 6, an additional 4' x 5' R/C box culvert under US-41, will provide adequate capacity to carry the runoff expected from a 100-year flood without overtopping the highway.

Installation of surface drainage projects in the Indian Village will protect yard and drive crossings from a 10-year flood.

Installation of Alternative 5 will result in 8 homes and businesses to be flooded by the 100-year flood. This is a flood damage reduction of 87 percent over Alternative 1.

ALTERNATIVE 6: <u>Dike Above Senior Citizens Housing Units on Center Drain and Required On-Site Detention of 100-Year Flood for all Future Development</u>

Components

Alternative 6 consists of Alternative 2 and a dike on Center Drain above the senior citizens housing units.

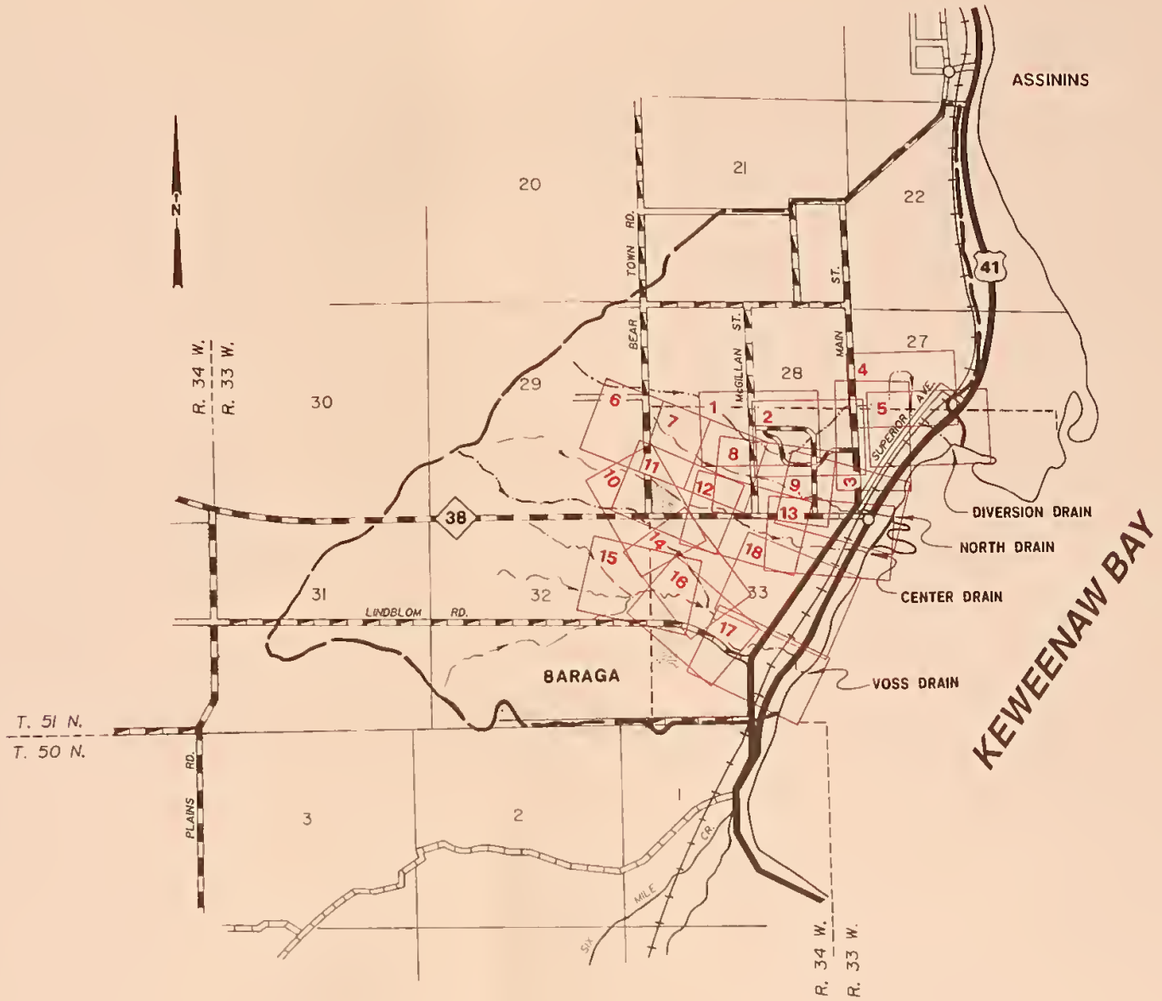
Effects

Installation of Alternative 6 will protect a 50-unit senior citizens housing unit from the 100-year flood. The on-site detention will prevent flooding and erosion problems from increasing due to future development. Alternative 6 will result in 162 homes and businesses to be flooded by the 100-year flood.

APPENDIX A

US DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE



VICINITY MAP

LEGEND

UNIMPROVED ROAD

GRAVEL OR SIMILAR ROAD

BITUMINOUS SURFACED ROAD

PAVED ROAD

UNITED STATES HIGHWAY 27

STATE HIGHWAY 13

RAILROAD (ANY NUMBER TRACKS) USED BY SINGLE OPERATING CO.

SHEET COVERAGE 3

WATERSHED BOUNDARY

NARROW STREAM

CIVIL TOWNSHIP BOUNDARY

SECTION LINE

UNINCORPORATED COMMUNITIES

INCORPORATED CITY OR VILLAGE

FIGURE 2

PHOTO SHEET INDEX MAP

Baraga Village

FLOOD PLAIN MANAGEMENT STUDY

BARAGA COUNTY, MICHIGAN

2400 1200 0 2400 4800

SCALE IN FEET

Approximate

BASE COMPILED FROM MICHIGAN COUNTY HIGHWAY MAP.

JUNE 1990 1006199-02

USDA SCS-NATIONAL CARTOGRAPHIC CENTER FT. WORTH, TX -1991

VALLEY SECTION

108.5

108.1

108.0

107.9

107.1

107.0

106.9

MCGILLAN STREET

SPRUCE STREET

LIMIT

STUDY

790

780

770

760

750

740

730

720

710

ELEVATION ABOVE MEAN SEA LEVEL
IN FEET
(BARAGA VILLAGE DATUM)

EXISTING CHANNEL BOTTOM

LOW BANK ELEVATION

500-YR.
100-YR.
10-YR.

80+00

82+50

85+00

87+50

90+00

92+50

95+00

97+50

100+00

STATIONS ALONG CENTERLINE
IN FEET

TOP OF ROAD
ROAD OVERFLOW

INLET INVERT
OUTLET INVERT

NOTE:
Additional field measured cross-sections may be needed to verify the water surface profile between the cross-sections used in this report. When the difference in the elevation of the channel bottom between cross-sections exceeds 2/3 the depth of flood flows, variations in the channel bottom can cause significant changes in the flood profiles

*Baraga Village Datum = USGS Elevation + 2.18 Feet

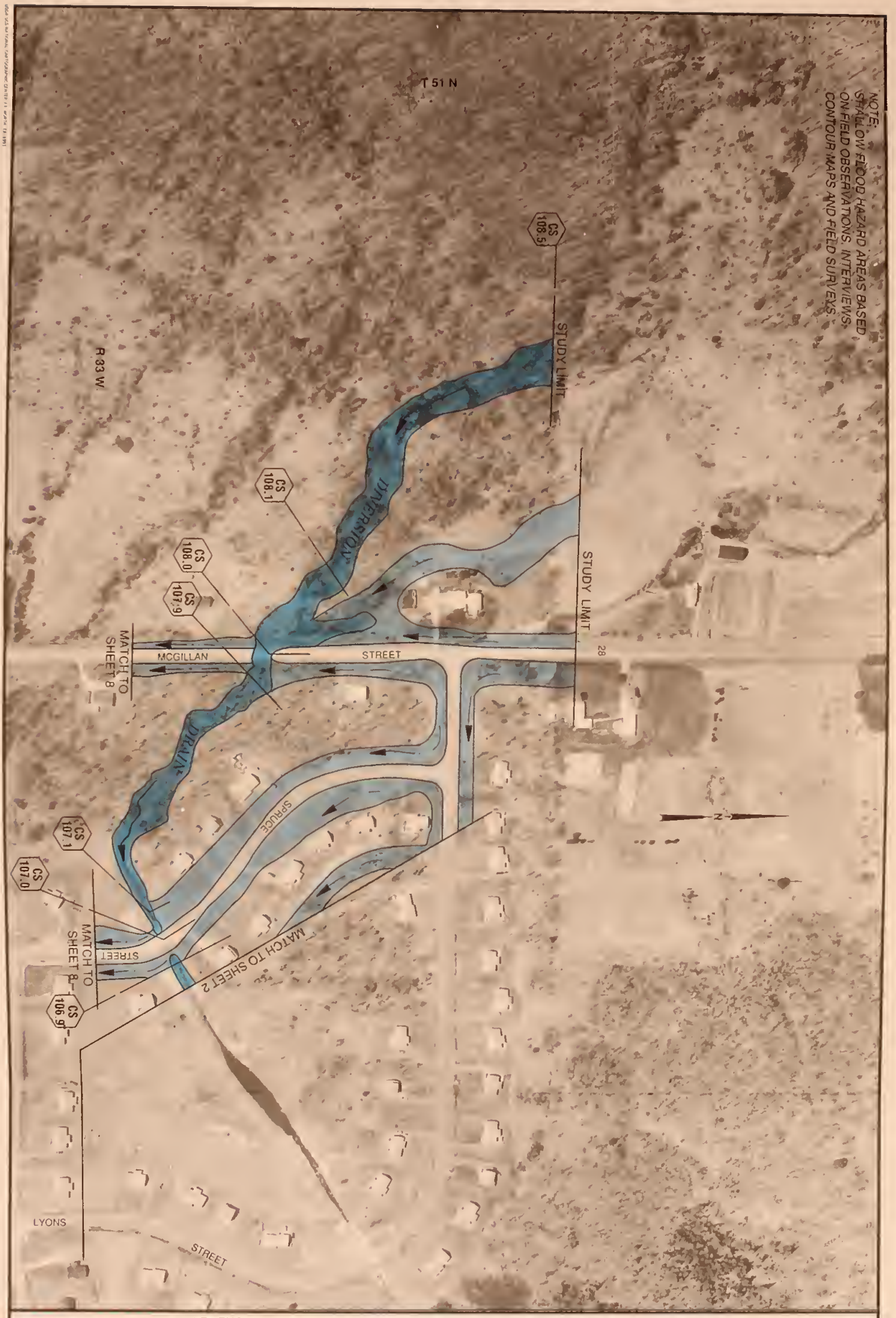
NOTE:
Depth of flow varies in shallow flood hazard areas.

DIVERSION DRAIN

HIGH WATER PROFILES
BARAGA VILLAGE
FLOOD PLAIN MANAGEMENT STUDY
BARAGA COUNTY, MICHIGAN

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed	Date	Approved By	
T.D. Bourdon	3-90	Title	
Drawn			
C.N. Wade J.E. Campau	3-90	Title	
Traced			
Checked		Sheet No. 1 of 17	Drawing No.
S.S. Davis, L.B. Hill	3-90		



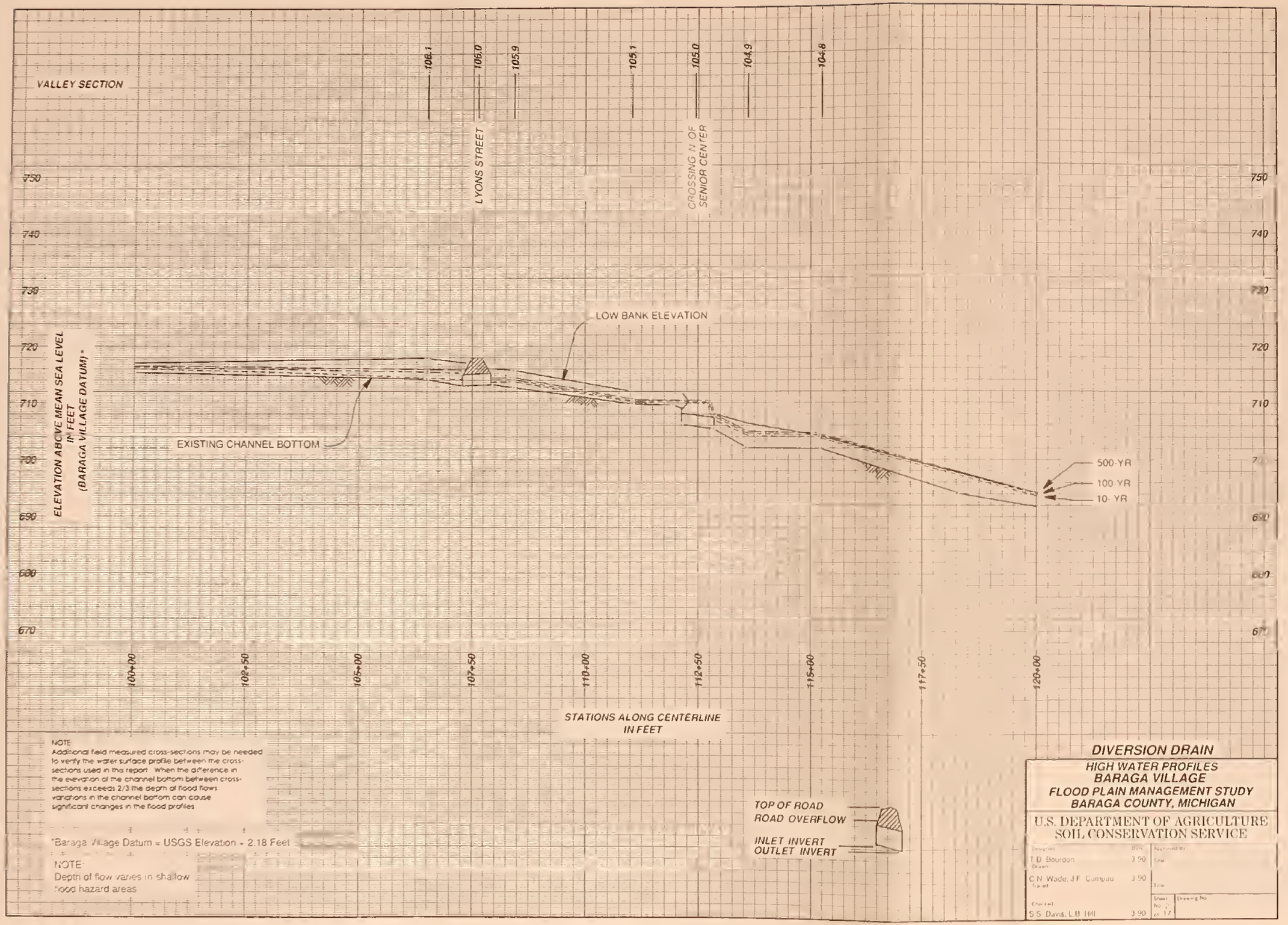
U S DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
BARAGA VILLAGE
FLOOD PLAIN MANAGEMENT STUDY
BARAGA COUNTY, MICHIGAN

SHEET 1 OF 15

FLOOD HAZARD AREA

BARAGA VILLAGE-DIVERSION DRAIN

JUNE 1990 1005200



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NOTE
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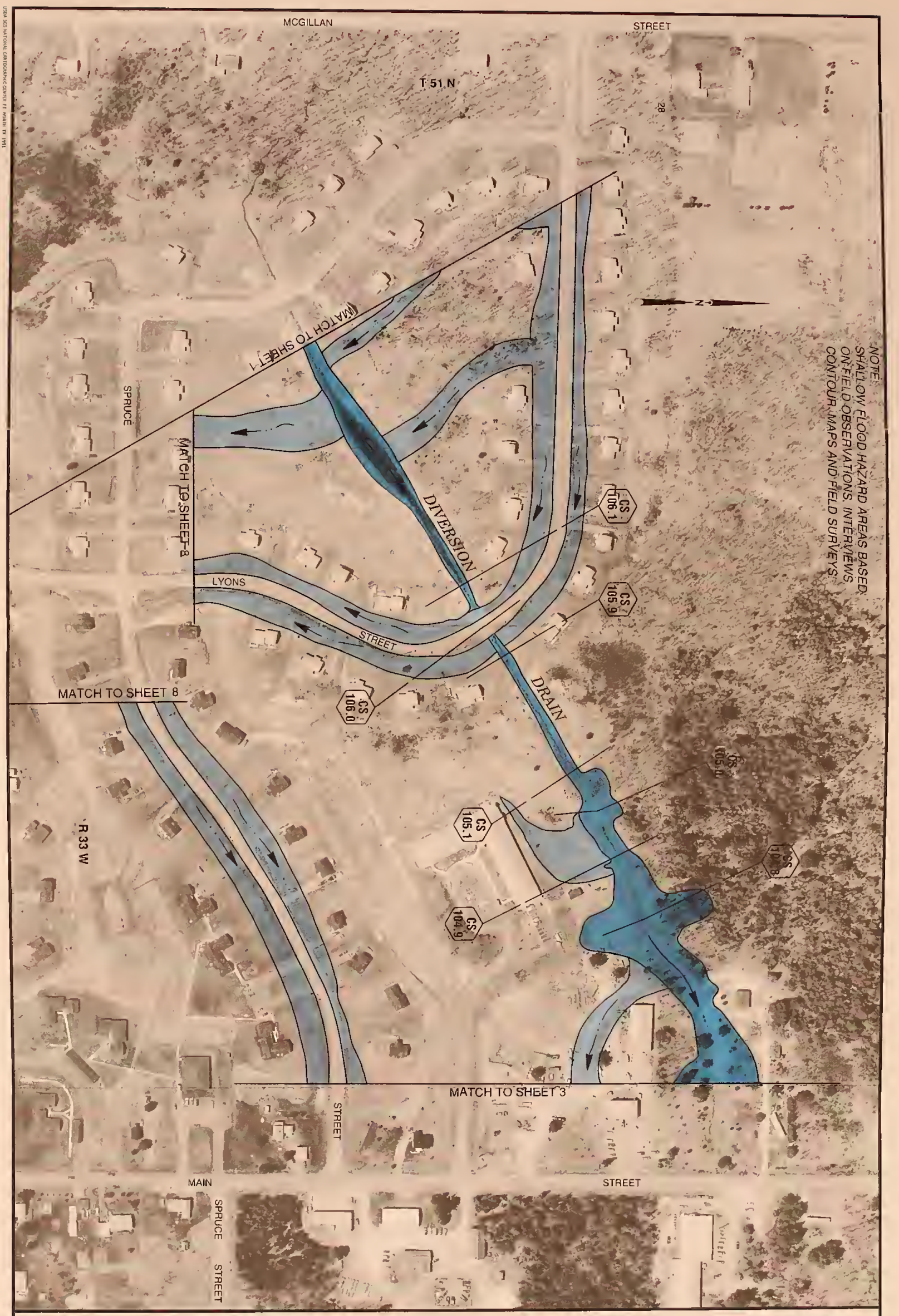
DIVERSION DRAIN

HIGH WATER PROFILES
BARAGA VILLAGE
FLOOD PLAIN MANAGEMENT STUDY
BARAGA COUNTY, MICHIGAN

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed	Date	Approved by
T.D. Bourdon	3-90	Title
Drawn		
C.N. Wade, J.F. Campau	3-90	Title
Traced		
Checked		Sheet No. 7 of 17
S.S. Davis, L.B. Hill	3-90	Drawing No.



LEGEND

- 100 & 500 Year Flood Hazard Area
- Shallow Flood Hazard Area
- Stream Channel
- CS 45.1 — Valley Section Location
- Flow direction

NOTE:
LIMITS OF FLOODING SHOWN MAY VARY FROM ACTUAL LOCATION ON THE GROUND AND DUE TO INHERENT AERIAL PHOTOGRAPHIC DISPLACEMENT THE PHOTOGRAPHIC IMAGE MAY VARY FROM TRUE GROUND LOCATION

SCALE 0 200 400 FEET
0 50 100 METERS
APPROXIMATE

1988 Photography From Abrams Aerial Survey Corp

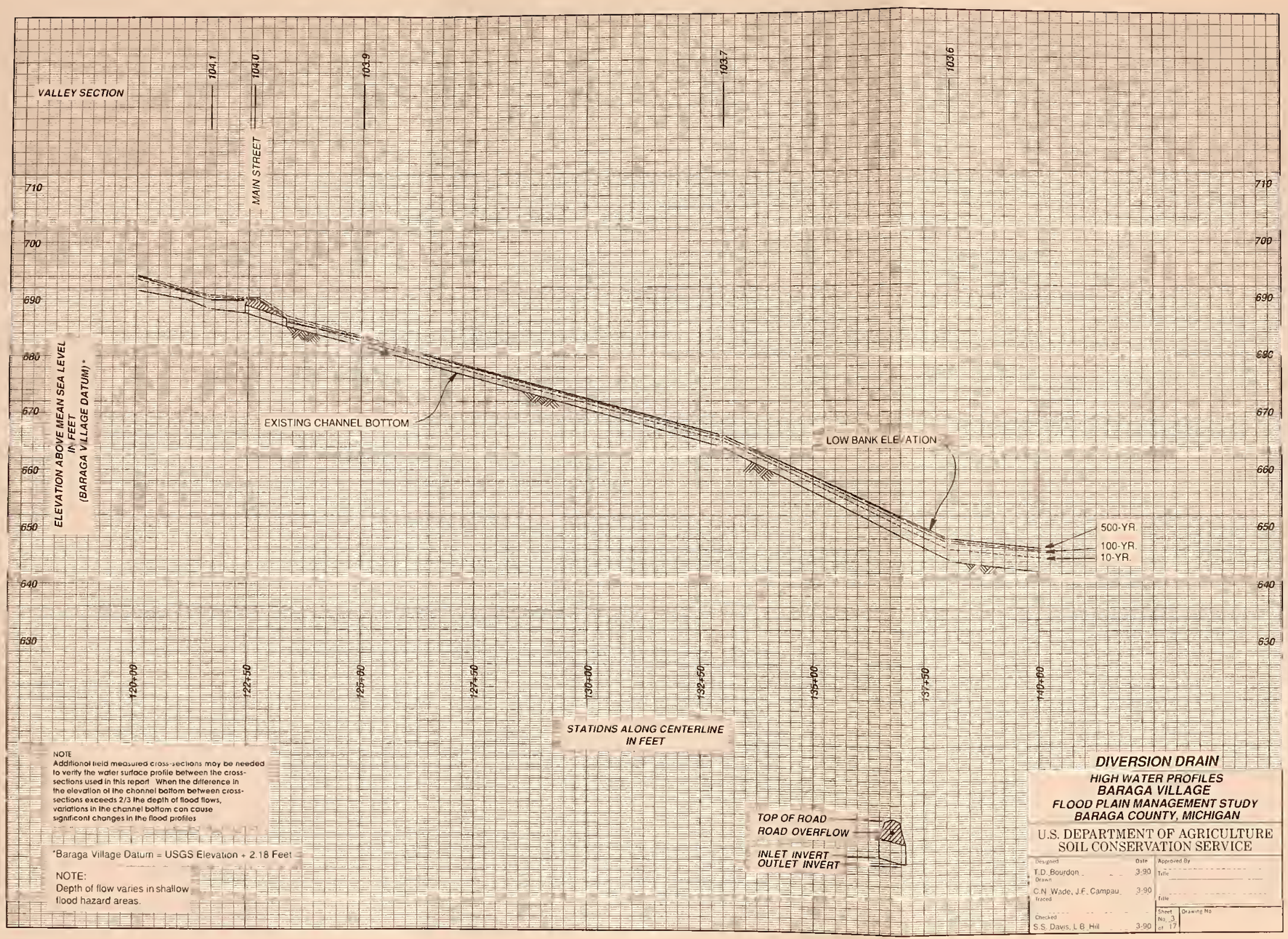
U S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
BARAGA VILLAGE
FLOOD PLAIN MANAGEMENT STUDY
BARAGA COUNTY, MICHIGAN

SHEET 2 OF 18

FLOOD HAZARD AREA

BARAGA VILLAGE-DIVERSION DRAIN

JUNE 1990 1006200



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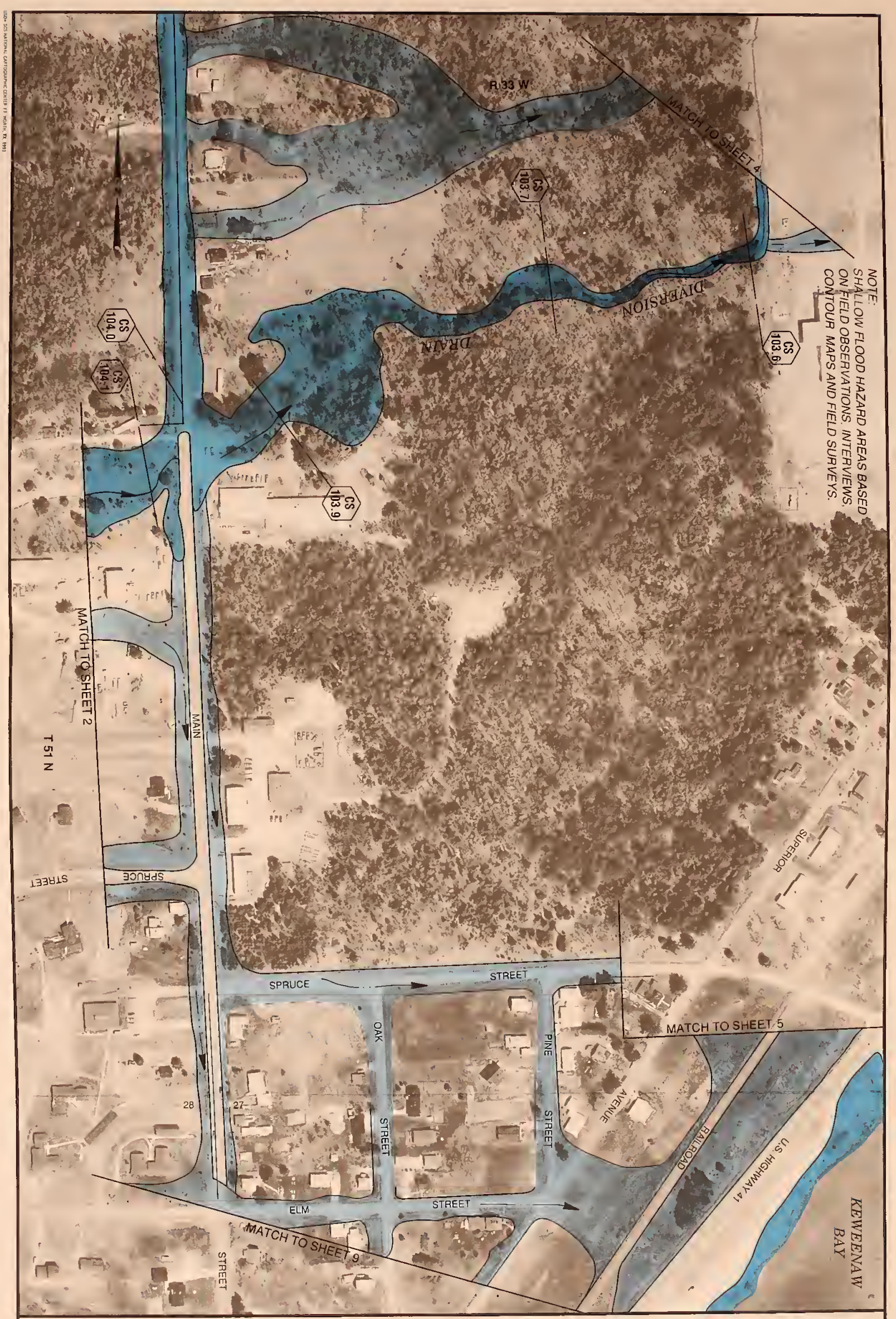
*Baraga Village Datum = USGS Elevation + 2.18 Feet

NOTE:
Depth of flow varies in shallow flood hazard areas.

DIVERSION DRAIN
HIGH WATER PROFILES
BARAGA VILLAGE
FLOOD PLAIN MANAGEMENT STUDY
BARAGA COUNTY, MICHIGAN

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed		Date	Approved By
T.D. Bourdon		3-90	Title
Drawn			
C.N. Wade, J.F. Campau		3-90	Title
Traced			
Checked			Sheet No. 3 of 17
S.S. Davis, L.B. Hill		3-90	Drawing No.



LEGEND

- 100 & 500 Year Flood Hazard Area
- Shallow Flood Hazard Area
- Stream Channel
- CS 45.1 — Valley Section Location
- Flow direction

NOTE.
LIMITS OF FLOODING SHOWN MAY VARY FROM ACTUAL LOCATION ON THE GROUND AND DUE TO INHERENT AERIAL PHOTOGRAPHIC DISPLACEMENT THE PHOTOGRAPHIC IMAGE MAY VARY FROM TRUE GROUND LOCATION

SCALE 0 200 400 FEET
0 50 100 METERS
APPROXIMATE

1988 Photgraphy From Abrams Aerial Survey Corp

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SOIL CONSERVATION SERVICE
BARAGA VILLAGE
FLOOD PLAIN MANAGEMENT STUDY
BARAGA COUNTY, MICHIGAN

FLOOD HAZARD AREA

BARAGA VILLAGE-DIVERSION DRAIN

SHEET 3 OF 18

JUNE 1990 1006200

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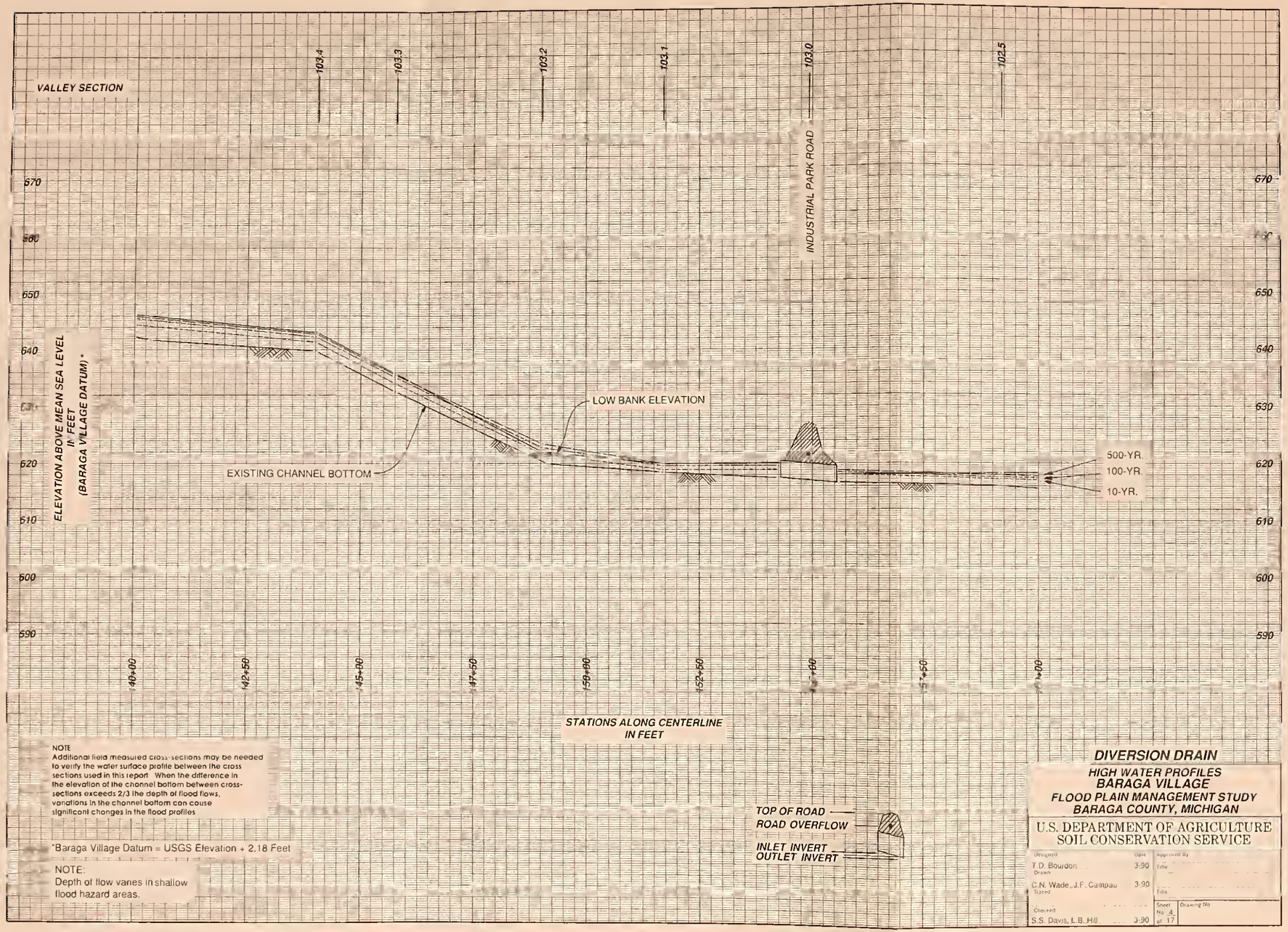

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NOTE:
Depth of flow varies in shallow flood hazard areas.

DIVERSION DRAIN

HIGH WATER PROFILES
BARAGA VILLAGE
FLOOD PLAIN MANAGEMENT STUDY
BARAGA COUNTY, MICHIGAN

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed		Date	Approved By
T.D. Bourdon		3-90	Title
Drawn			
C.N. Wade, J.F. Campau		3-90	
Traced			Title
Checked			Sheet No. 4 of 17
S.S. Davis, L.B. Hill		3-90	Drawing No.

NOTE:
SHALLOW FLOOD HAZARD AREAS BASED ON FIELD OBSERVATIONS, INTERVIEWS, CONTOUR MAPS AND FIELD SURVEYS.

MAIN STREET

T 51 N.

R 33 W

MATCH TO SHEET 3

MATCH TO SHEET 5

DIVERSION

DRAIN

INDUSTRIAL PARK ROAD

AVENUE

SUPERIOR

RAILROAD

U.S. HIGHWAY 41

CS 103.4
CS 103.3
CS 103.2
CS 102.5
CS 103.0
CS 103.1

LEGEND

100 & 500 Year Flood Hazard Area
Shallow Flood Hazard Area
Stream Channel
CS 45.1 Valley Section Location
Flow direction

NOTE:
LIMITS OF FLOODING SHOWN MAY VARY FROM ACTUAL LOCATION ON THE GROUND AND DUE TO INHERENT AERIAL PHOTOGRAPHIC DISPLACEMENT THE PHOTOGRAPHIC IMAGE MAY VARY FROM TRUE GROUND LOCATION

SCALE 0 200 400 FEET
0 50 100 METERS
APPROXIMATE

1988 Photgraphy From Abrams Aerial Survey Corp.

SHEET 4 OF 18

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SOIL CONSERVATION SERVICE
BARAGA VILLAGE
FLOOD PLAIN MANAGEMENT STUDY
BARAGA COUNTY, MICHIGAN

FLOOD HAZARD AREA

BARAGA VILLAGE-DIVERSION DRAIN

JUNE 1990 1006200

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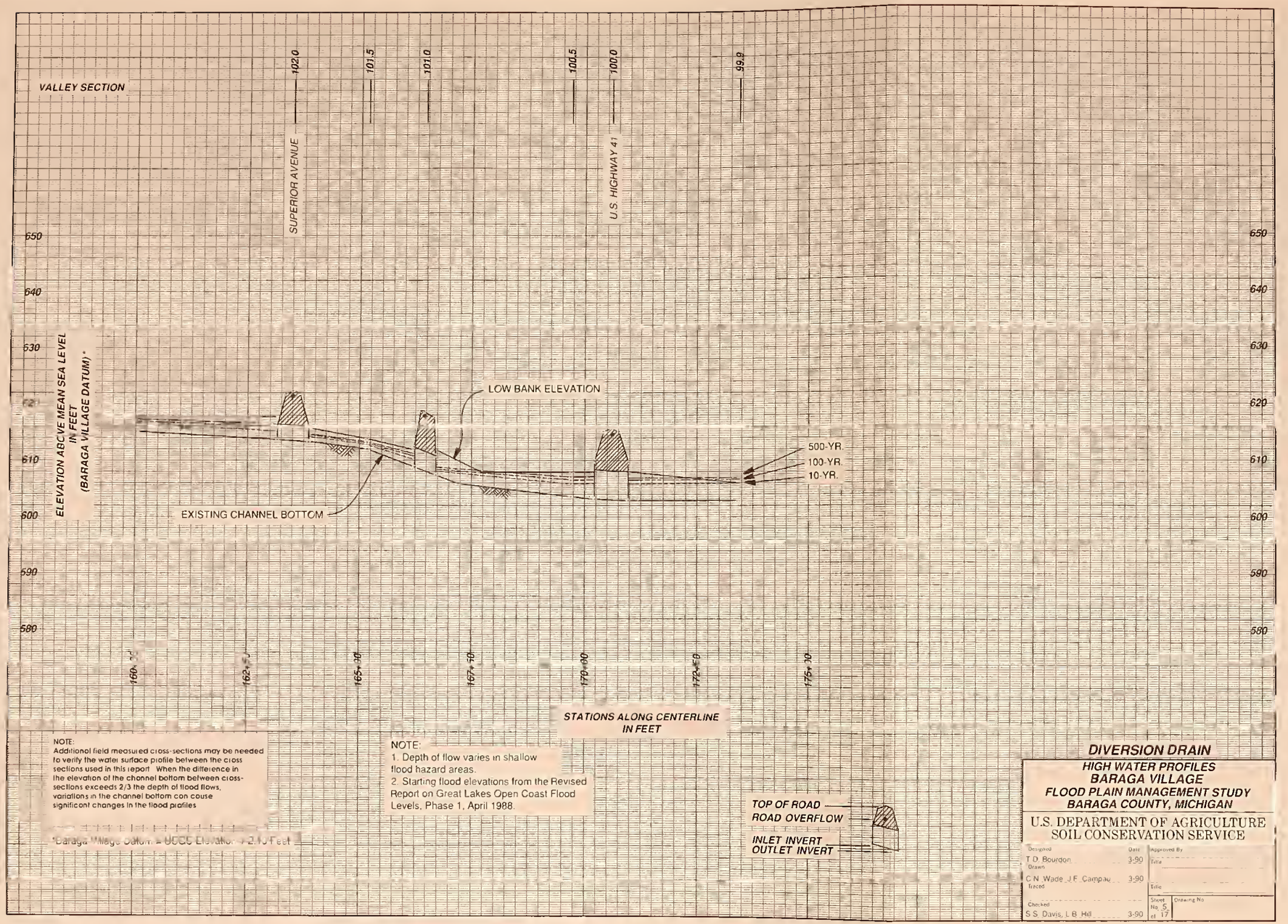
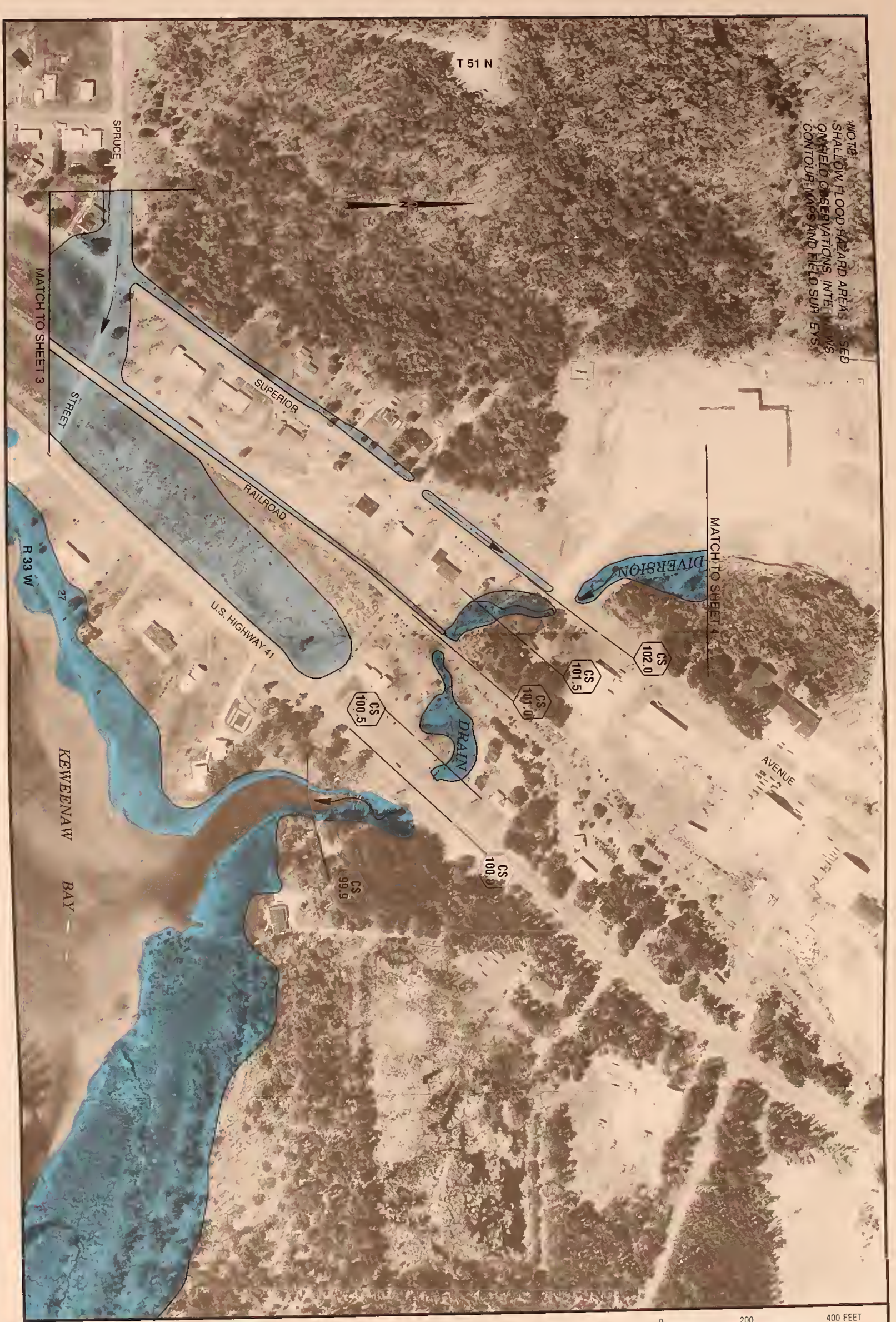

VALLEY SECTION
102.0
101.5
101.0
100.5
100.0
99.8
SUPERIOR AVENUE
U.S. HIGHWAY 41
650
640
630
620
610
600
590
580
ELEVATION ABOVE MEAN SEA LEVEL IN FEET (BARAGA VILLAGE DATUM) *
LOW BANK ELEVATION
500-YR.
100-YR.
10-YR.
EXISTING CHANNEL BOTTOM
160+ 30
162+ 50
165+ 30
167+ 50
170+ 90
172+ 60
175+ 30
STATIONS ALONG CENTERLINE IN FEET
NOTE:
Additional field measured cross-sections may be needed to verify the water surface profile between the cross sections used in this report. When the difference in the elevation of the channel bottom between cross-sections exceeds 2/3 the depth of flood flows, variations in the channel bottom can cause significant changes in the flood profiles
*Baraga Village Datum = USCG Elevation + 2.10 Feet
NOTE:
1. Depth of flow varies in shallow flood hazard areas.
2. Starting flood elevations from the Revised Report on Great Lakes Open Coast Flood Levels, Phase 1, April 1988.
TOP OF ROAD
ROAD OVERFLOW
INLET INVERT
OUTLET INVERT
DIVERSION DRAIN
HIGH WATER PROFILES
BARAGA VILLAGE
FLOOD PLAIN MANAGEMENT STUDY
BARAGA COUNTY, MICHIGAN
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
Designed T.D. Bourdon 3-90
Drawn C.N. Wade, J.F. Campau 3-90
Traced
Checked S.S. Davis, L.B. Hill 3-90
Approved By
Title
Sheet No. 5 of 17
Drawing No.


NOTE:
SHALLOW FLOOD HAZARD AREAS - SEED
ON-FIELD OBSERVATIONS, INTERVIEWS
CONTOUR MAPS AND FIELD SURVEYS
T 51 N
SPRUCE
MATCH TO SHEET 3
SUPERIOR
STREET
RAILROAD
U.S. HIGHWAY 41
R 33 W
27
KEWEENAW
BAY
DIVERSION
MATCH TO SHEET 4
DRAIN
AVENUE
CS 102.0
CS 101.5
CS 101.0
CS 100.5
CS 100.0
CS 99.9
LEGEND
100 & 500 Year Flood Hazard Area
Shallow Flood Hazard Area
Stream Channel
CS 45.1
Valley Section Location
Flow direction
NOTE:
LIMITS OF FLOODING SHOWN MAY VARY FROM ACTUAL LOCATION ON THE GROUND AND DUE TO INHERENT AERIAL PHOTOGRAPHIC DISPLACEMENT THE PHOTOGRAPHIC IMAGE MAY VARY FROM TRUE GROUND LOCATION
SCALE
0 200 400 FEET
0 50 100 METERS
APPROXIMATE
1988 Photography From Abrams Aerial Survey Corp
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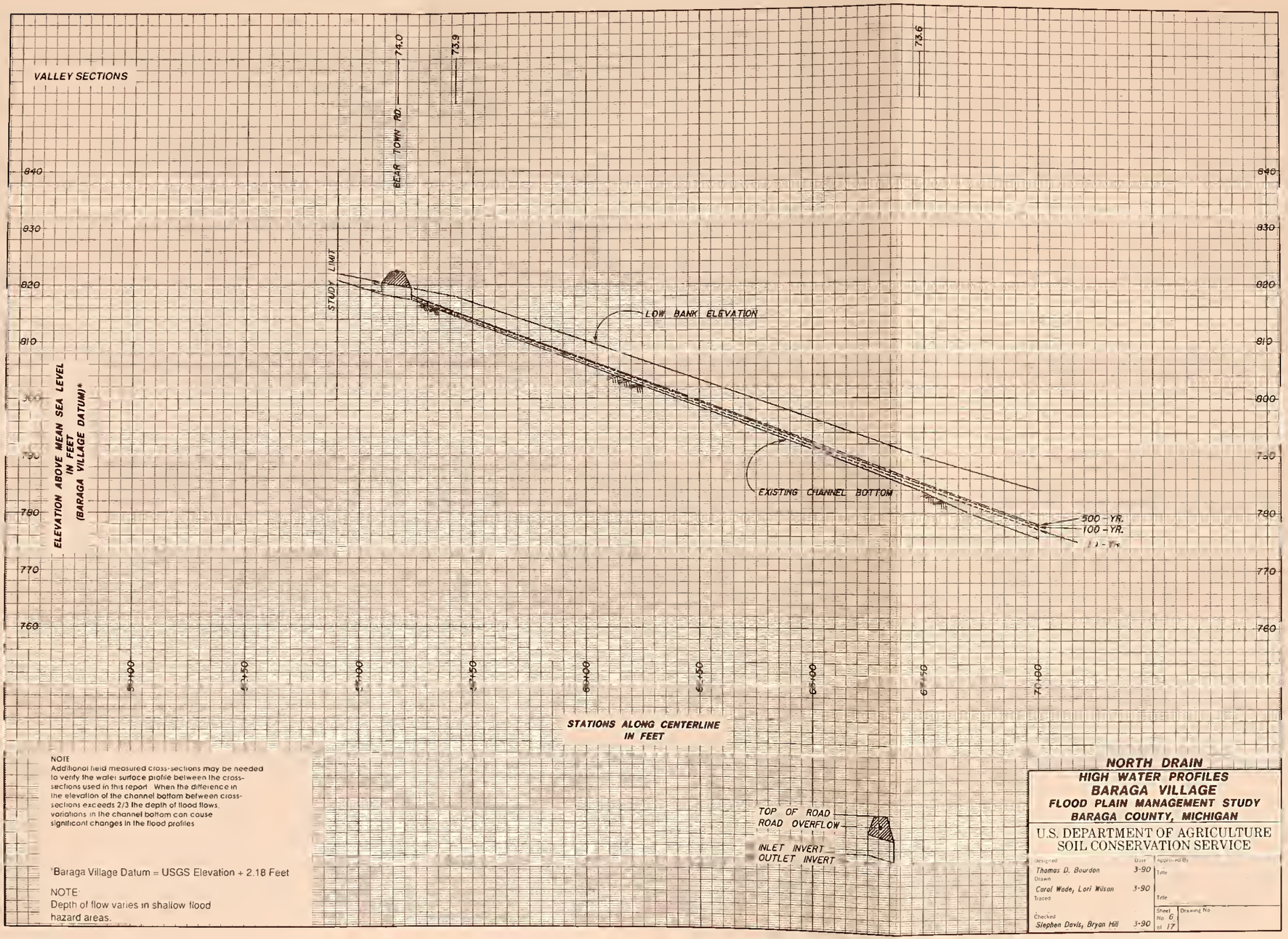
SOIL CONSERVATION SERVICE
BARAGA VILLAGE
FLOOD PLAIN MANAGEMENT STUDY
BARAGA COUNTY, MICHIGAN
SHEET 5 OF 18
FLOOD HAZARD AREA
BARAGA VILLAGE-DIVERSION DRAIN
JUNE 1990 1006200
USDA SCS NATIONAL CARTOGRAPHIC CENTER FT WORTH TX 1991



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*Baraga Village Datum = USGS Elevation + 2.18 Feet

NOTE
Depth of flow varies in shallow flood hazard areas.

NORTH DRAIN
HIGH WATER PROFILES
BARAGA VILLAGE
FLOOD PLAIN MANAGEMENT STUDY
BARAGA COUNTY, MICHIGAN

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed	Thomas D. Bourdon	Date 3-90	Approved By
Drawn	Carol Wade, Lori Wilson	3-90	Title
Traced			Title
Checked	Stephen Davis, Bryan Hill	3-90	Sheet No 6 of 17
			Drawing No

T 51 N

R 33 W

NOTE:
SHALLOW FLOOD HAZARD AREAS BASED ON FIELD OBSERVATIONS, INTERVIEWS, CONTOUR MAPS AND FIELD SURVEYS.

STUDY LIMIT

BEAR TOWN ROAD

CS 74.0

CS 73.9

NORTH DRAIN

CS 73.6

MATCH TO SHEET 10

MATCH TO SHEET 7

29

28

LEGEND

- 100 & 500 Year Flood Hazard Area
- Shallow Flood Hazard Area
- Stream Channel
- CS 45.1 Valley Section Location
- Flow direction

NOTE
LIMITS OF FLOODING SHOWN MAY VARY FROM ACTUAL LOCATION ON THE GROUND AND DUE TO INHERENT AERIAL PHOTOGRAPHIC DISPLACEMENT THE PHOTOGRAPHIC IMAGE MAY VARY FROM TRUE GROUND LOCATION.

SCALE 0 200 400 FEET
0 50 100 METERS
APPROXIMATE

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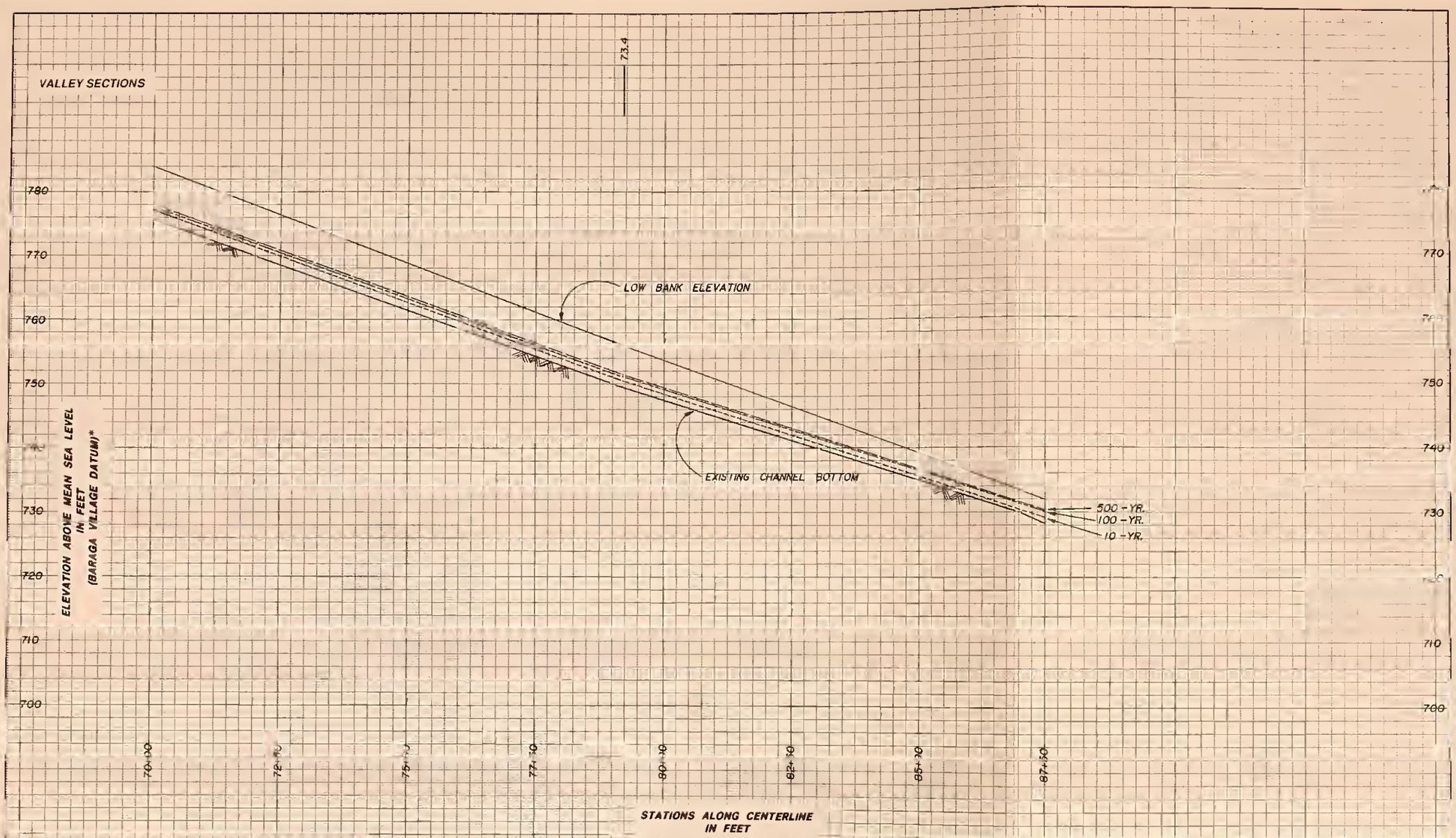
SOIL CONSERVATION SERVICE
BARAGA VILLAGE
FLOOD PLAIN MANAGEMENT STUDY
BARAGA COUNTY, MICHIGAN

SHEET 6 OF 18

FLOOD HAZARD AREA

BARAGA VILLAGE-NORTH DRAIN

JUNE 1990 1006200



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NORTH DRAIN
HIGH WATER PROFILES
BARAGA VILLAGE
FLOOD PLAIN MANAGEMENT STUDY
BARAGA COUNTY, MICHIGAN

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed	Date	Approved By	
T. D. Bourdon	3-90	Title	
Drawn			
C. N. Wade, L. Wilson	3-90		
Traced		Title	
Checked		Sheet No. 7 of 17	Drawing No.
S. S. Davis, L. B. Hill	3-90		

LEGEND

- 100 & 500 Year Flood Hazard Area
- Shallow Flood Hazard Area
- Stream Channel
- CS 45.1 — Valley Section Location
- Flow direction

NOTE
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SCALE 0 200 400 FEET
0 50 100 METERS
APPROXIMATE

1988 Photography From Abrams Aerial Survey Corp

U S DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
BARAGA VILLAGE
FLOOD PLAIN MANAGEMENT STUDY
BARAGA COUNTY, MICHIGAN

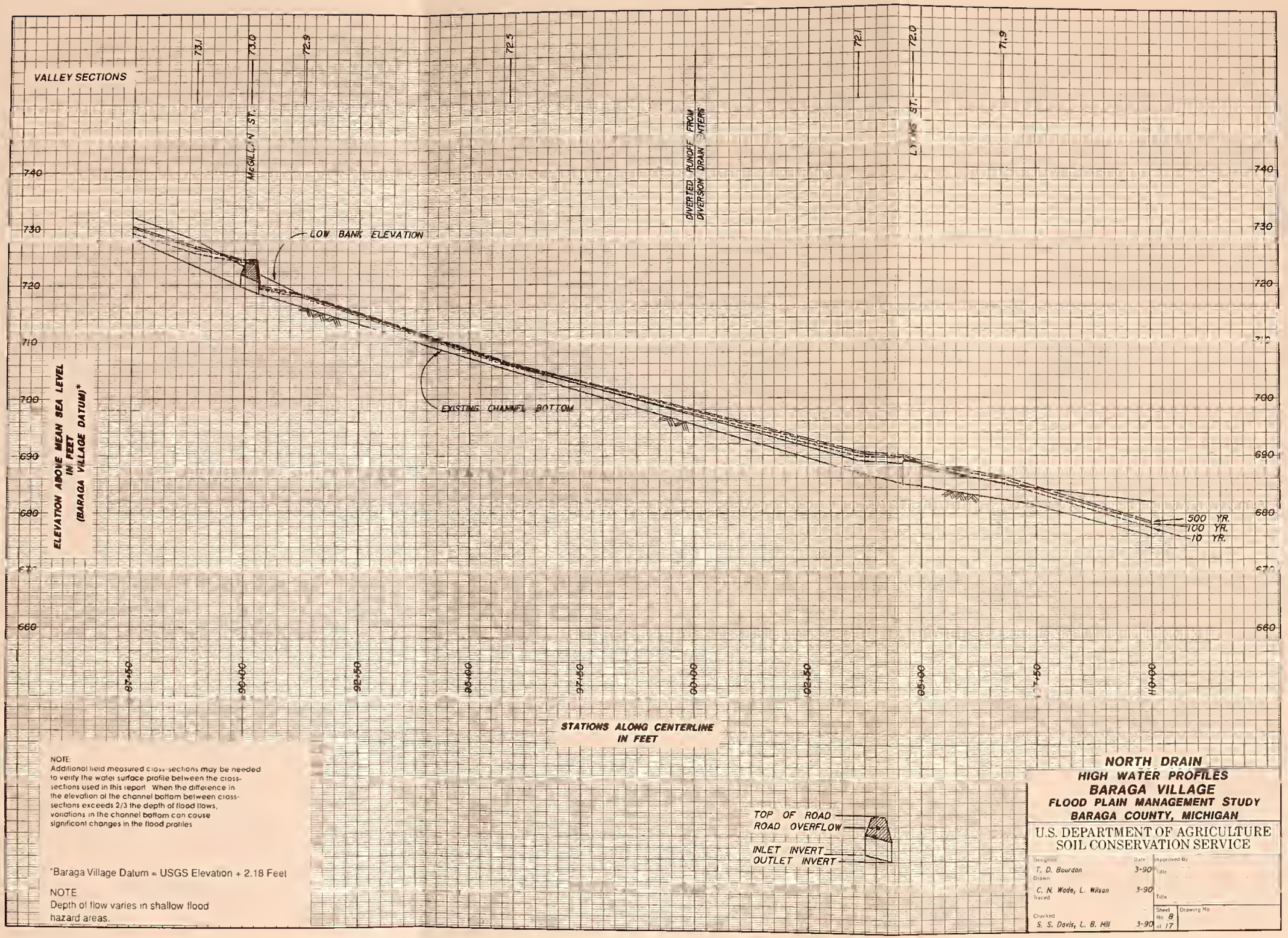
FLOOD HAZARD AREA

BARAGA VILLAGE-NORTH DRAIN

SHEET 7 OF 18

JUNE 1990 1096200

USDA SCS NATIONAL CARTOGRAPHIC CENTER FT WORTH TX 1991



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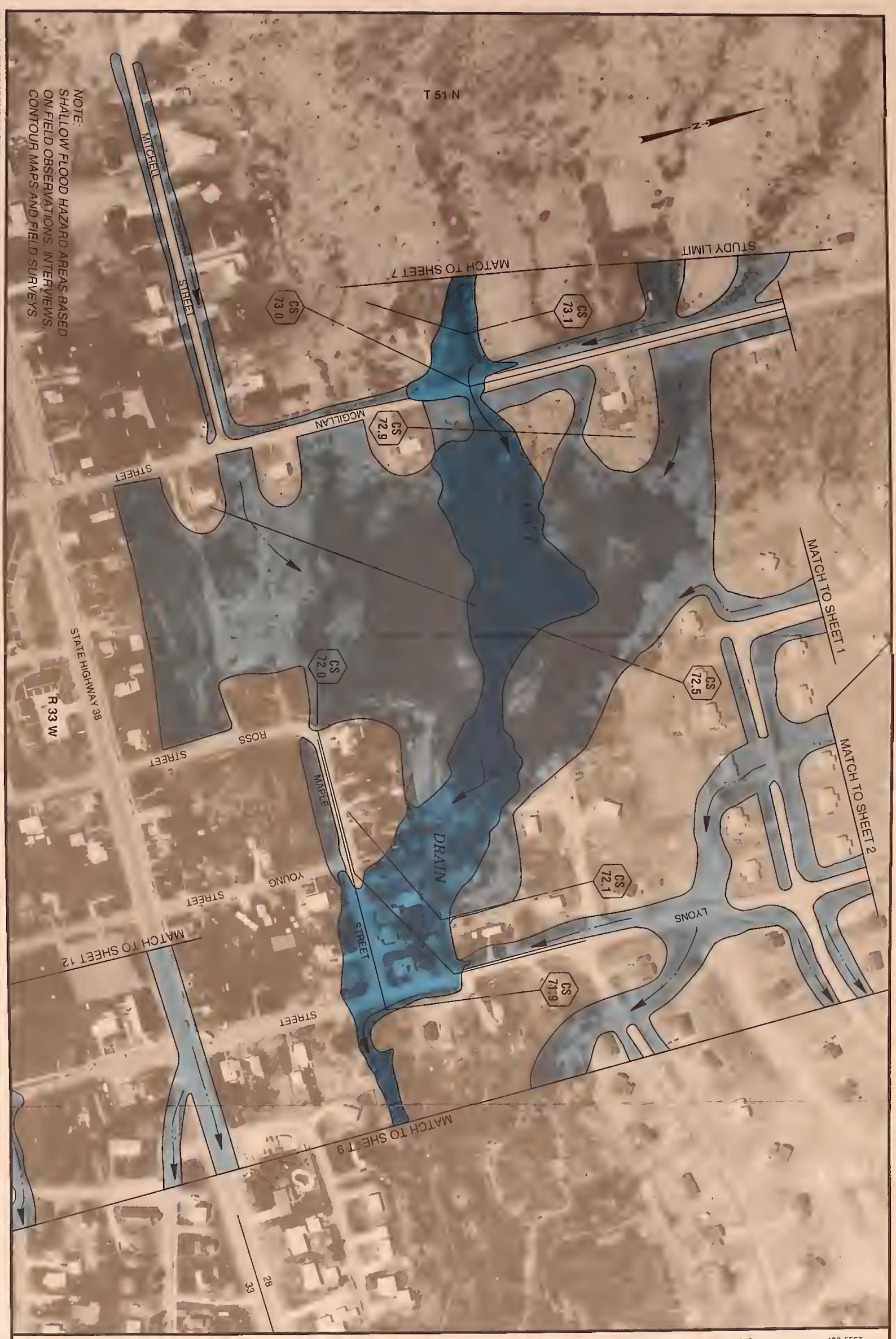
NORTH DRAIN
HIGH WATER PROFILES
BARAGA VILLAGE
FLOOD PLAIN MANAGEMENT STUDY
BARAGA COUNTY, MICHIGAN

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed	Date	Approved By	
T. D. Bourdon	3-90	Title	
Drawn			
C. N. Wade, L. Wilson	3-90		
Traced		Title	
Checked		Sheet No 8 of 17	Drawing No
S. S. Davis, L. B. Hill	3-90		



NOTE:
SHALLOW FLOOD HAZARD AREAS BASED ON FIELD OBSERVATIONS, INTERVIEWS, CONTOUR MAPS AND FIELD SURVEYS.

LEGEND

- 100 & 500 Year Flood Hazard Area
- Shallow Flood Hazard Area
- Stream Channel
- CS 45.1 — Valley Section Location
- Flow direction

NOTE:
LIMITS OF FLOODING SHOWN MAY VARY FROM ACTUAL LOCATION ON THE GROUND AND DUE TO INHERENT AERIAL PHOTOGRAPHIC DISPLACEMENT THE PHOTOGRAPHIC IMAGE MAY VARY FROM TRUE GROUND LOCATION

SCALE 0 200 400 FEET
0 50 100 METERS
APPROXIMATE

1988 Photgraphy From Abrams Aerial Survey Corp

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SOIL CONSERVATION SERVICE
BARAGA VILLAGE
FLOOD PLAIN MANAGEMENT STUDY
BARAGA COUNTY, MICHIGAN

FLOOD HAZARD AREA

BARAGA VILLAGE-NORTH DRAIN

SHEET 8 OF 18

JUNE 1990 1006200

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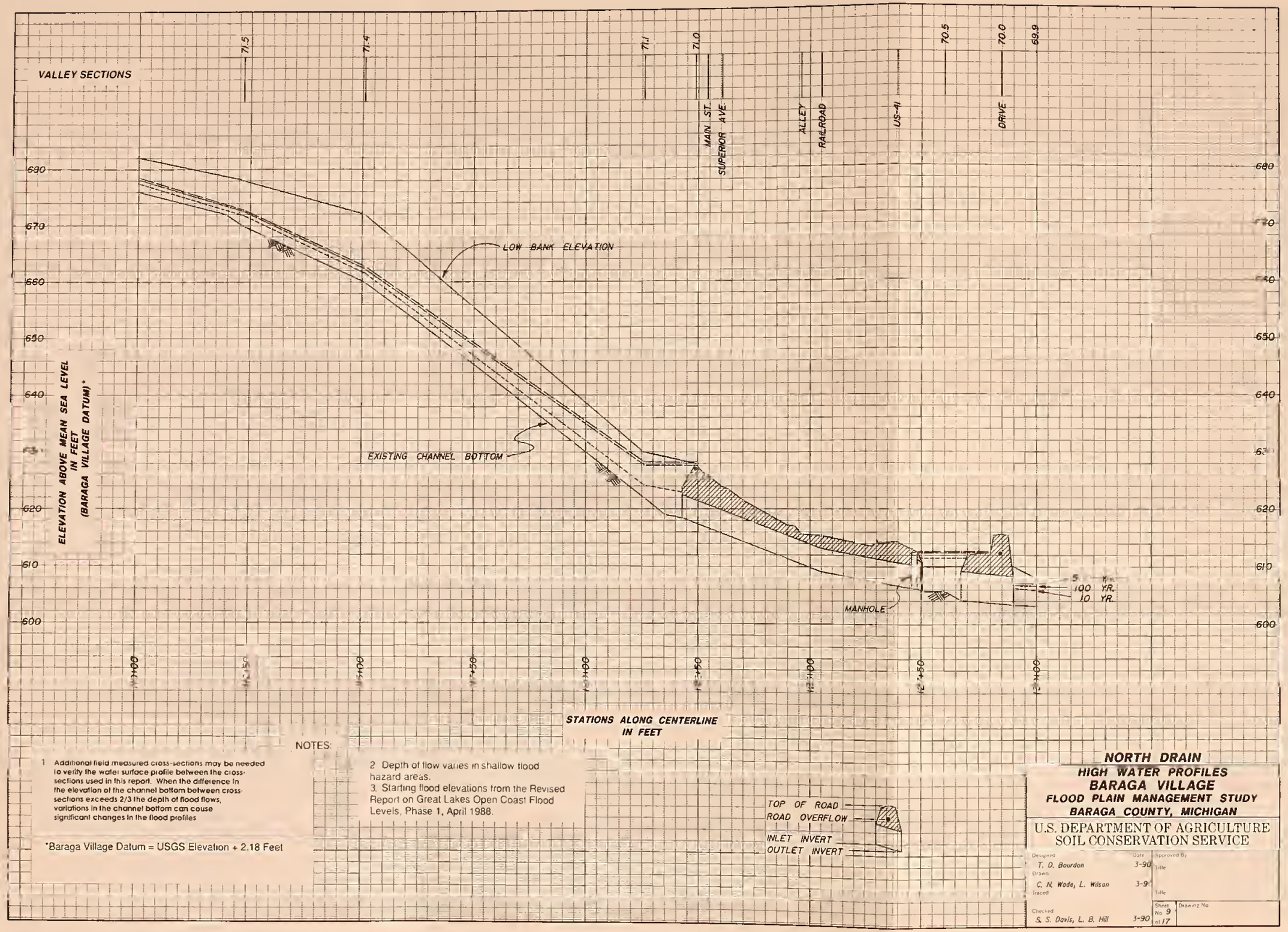

NOTES:

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2 Depth of flow varies in shallow flood hazard areas.

3. Starting flood elevations from the Revised Report on Great Lakes Open Coast Flood Levels, Phase 1, April 1988.

*Baraga Village Datum = USGS Elevation + 2.18 Feet

NORTH DRAIN
HIGH WATER PROFILES
BARAGA VILLAGE
FLOOD PLAIN MANAGEMENT STUDY
BARAGA COUNTY, MICHIGAN

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed	T. D. Bourdon	Date 3-90	Approved By Title
Drawn	C. N. Wade, L. Wilson	3-90	Title
Traced			Title
Checked	S. S. Davis, L. B. Hill	3-90	Sheet No. 9 of 17

Drawing No.

LEGEND

- 100 & 500 Year Flood Hazard Area
- Shallow Flood Hazard Area
- Stream Channel
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- Flow direction

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BARAGA COUNTY, MICHIGAN

FLOOD HAZARD AREA

BARAGA VILLAGE-NORTH DRAIN

SHEET 9 OF 18

JUNE 1990 1006200

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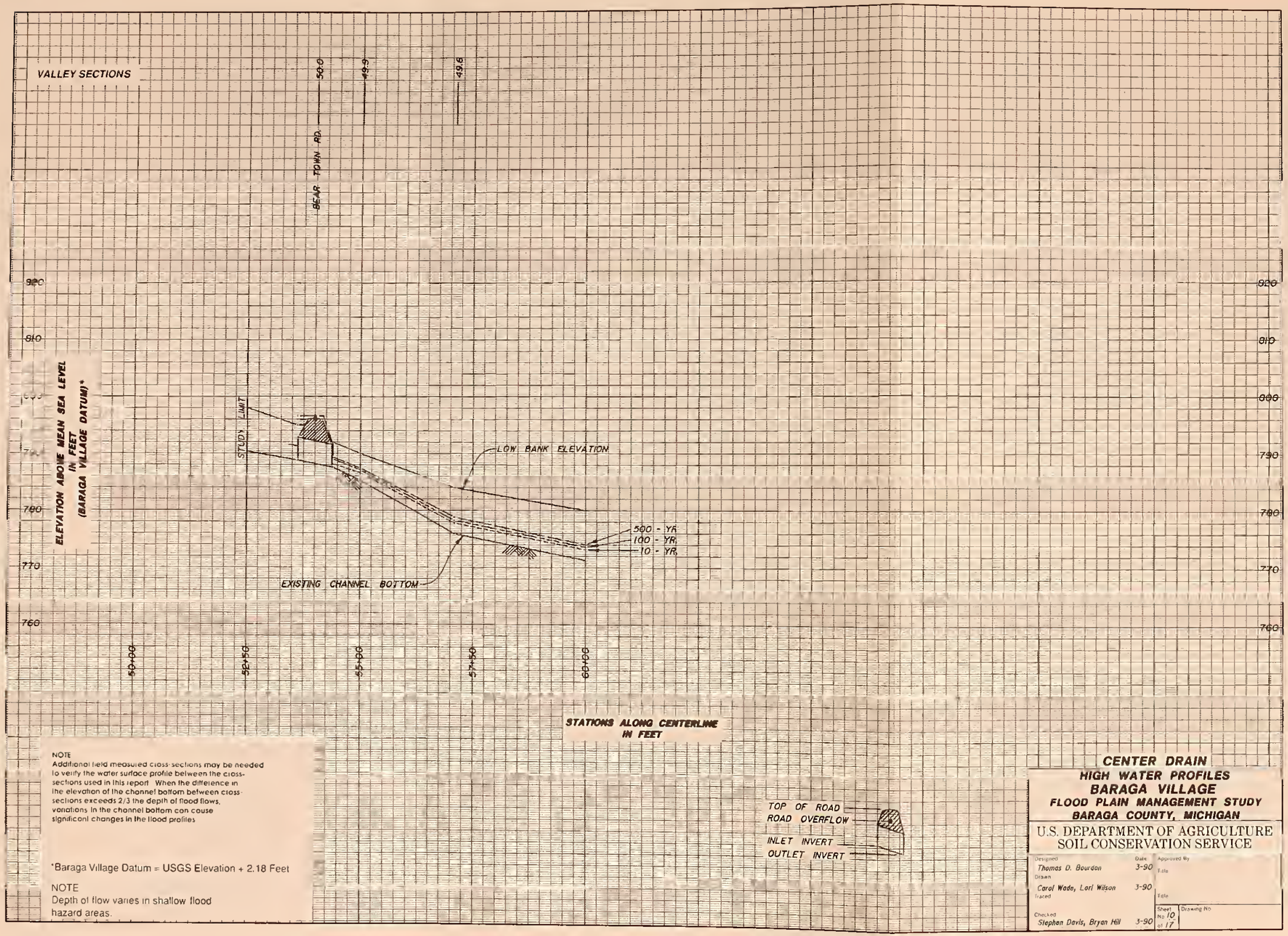
VALLEY SECTIONS



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CENTER DRAIN
HIGH WATER PROFILES
BARAGA VILLAGE
FLOOD PLAIN MANAGEMENT STUDY
BARAGA COUNTY, MICHIGAN

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed	Thomas D. Bourdon	3-90	Approved By
Drawn	Carol Wade, Lori Wilson	3-90	Title
Traced			Title
Checked	Stephen Davis, Bryan Hill	3-90	Sheet No. 10 of 17 — Drawing No.

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LEGEND

- 100 & 500 Year Flood Hazard Area
- Shallow Flood Hazard Area
- Stream Channel
- CS 45.1 — Valley Section Location
- Flow direction

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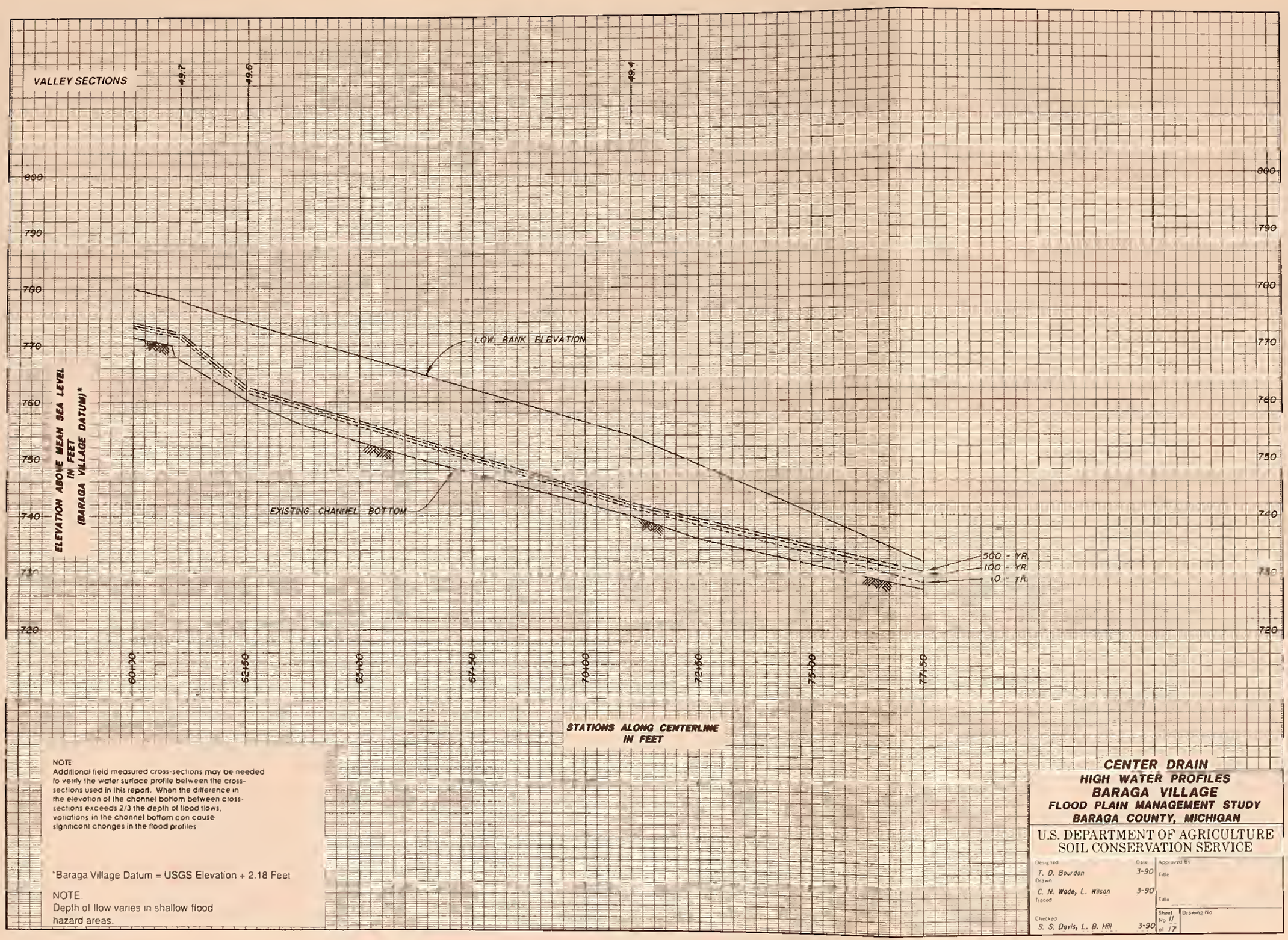
BARAGA COUNTY, MICHIGAN

FLOOD HAZARD AREA

BARAGA VILLAGE-CENTER DRAIN

SHEET 10 OF 18

JUNE 1990 1006200



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CENTER DRAIN
HIGH WATER PROFILES
BARAGA VILLAGE
FLOOD PLAIN MANAGEMENT STUDY
BARAGA COUNTY, MICHIGAN

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed	Date	Approved By	
T. D. Bourdon	3-90	Title	
Drawn			
C. N. Wade, L. Wilson	3-90	Title	
Traced			
Checked		Sheet No. 11 of 17	Drawing No.
S. S. Davis, L. B. Hill	3-90		

T 51 N

R 33 W

BEAR TOWN ROAD

MATCH TO SHEET 10

MATCH TO SHEET 12

CS 49.7

CS 49.6

CS 49.4

CENTER DRAIN

STATE HIGHWAY 38

MITCHELL STREET

29 28 2 33

NOTE:
SHALLOW FLOOD HAZARD AREAS BASED ON FIELD OBSERVATIONS, INTERVIEWS, CONTOUR MAPS AND FIELD SURVEYS.

LEGEND

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APPROXIMATE

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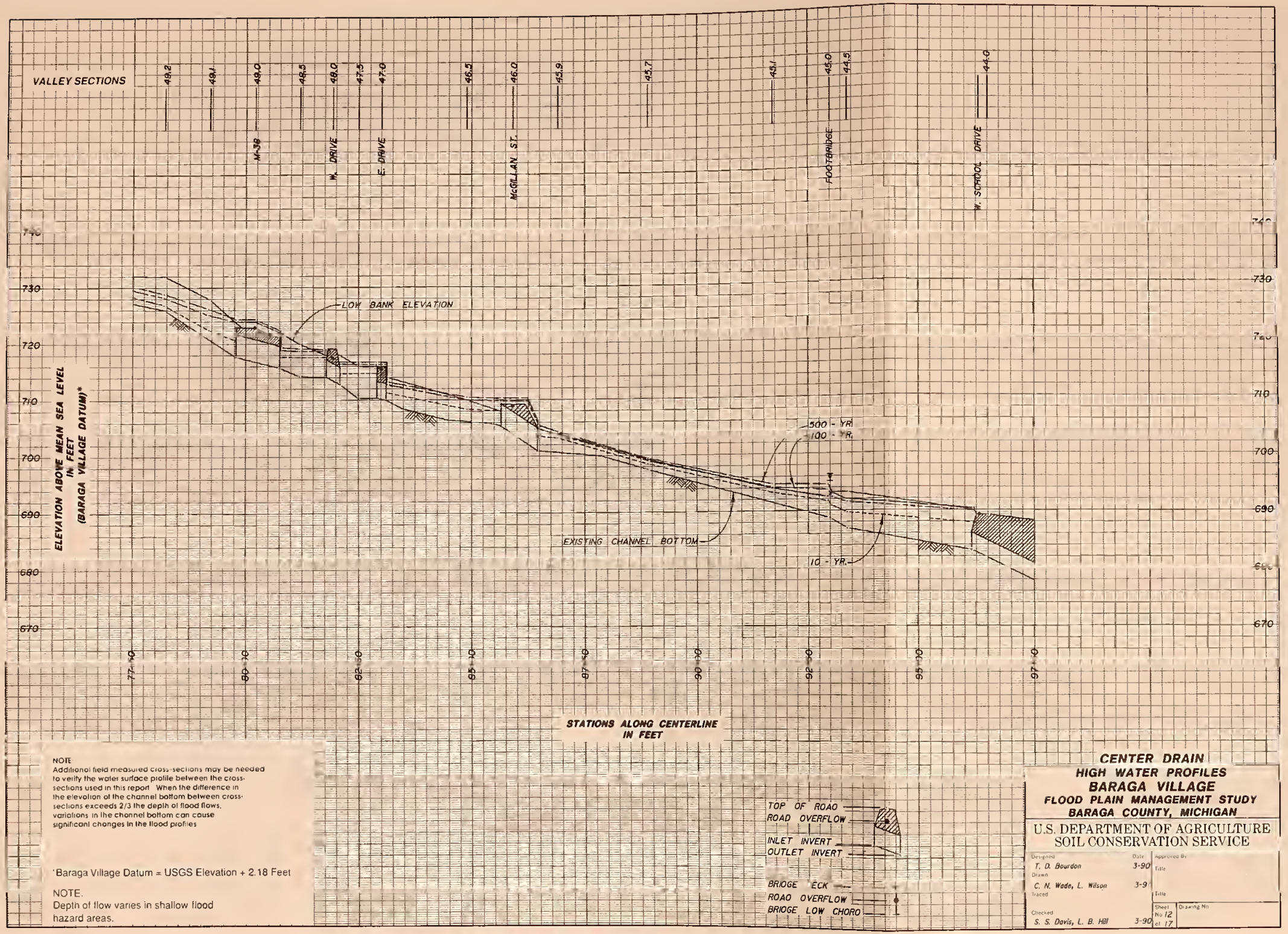
BARAGA COUNTY, MICHIGAN

FLOOD HAZARD AREA

BARAGA VILLAGE-CENTER DRAIN

SHEET 11 OF 18

JUNE 1990 1006200



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NOTE.
Depth of flow varies in shallow flood hazard areas.

CENTER DRAIN
HIGH WATER PROFILES
BARAGA VILLAGE
FLOOD PLAIN MANAGEMENT STUDY
BARAGA COUNTY, MICHIGAN

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed	T. D. Bourdon	Date 3-90	Approved By
Drawn	C. N. Wade, L. Wilson	3-9	Title
Traced			Title
Checked	S. S. Davis, L. B. Hill	3-90	Sheet No 12 of 17 — Drawing No

NOTE:
SHALLOW FLOOD HAZARD AREAS BASED ON FIELD OBSERVATIONS, INTERVIEWS, CONTOUR MAPS AND FIELD SURVEYS.

LEGEND

- 100 & 500 Year Flood Hazard Area
- Shallow Flood Hazard Area
- Stream Channel
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- Flow direction

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SOIL CONSERVATION SERVICE
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FLOOD PLAIN MANAGEMENT STUDY
BARAGA COUNTY, MICHIGAN

FLOOD HAZARD AREA

BARAGA VILLAGE-CENTER DRAIN

SHEET 12 OF 18

JUNE 1990 1006200

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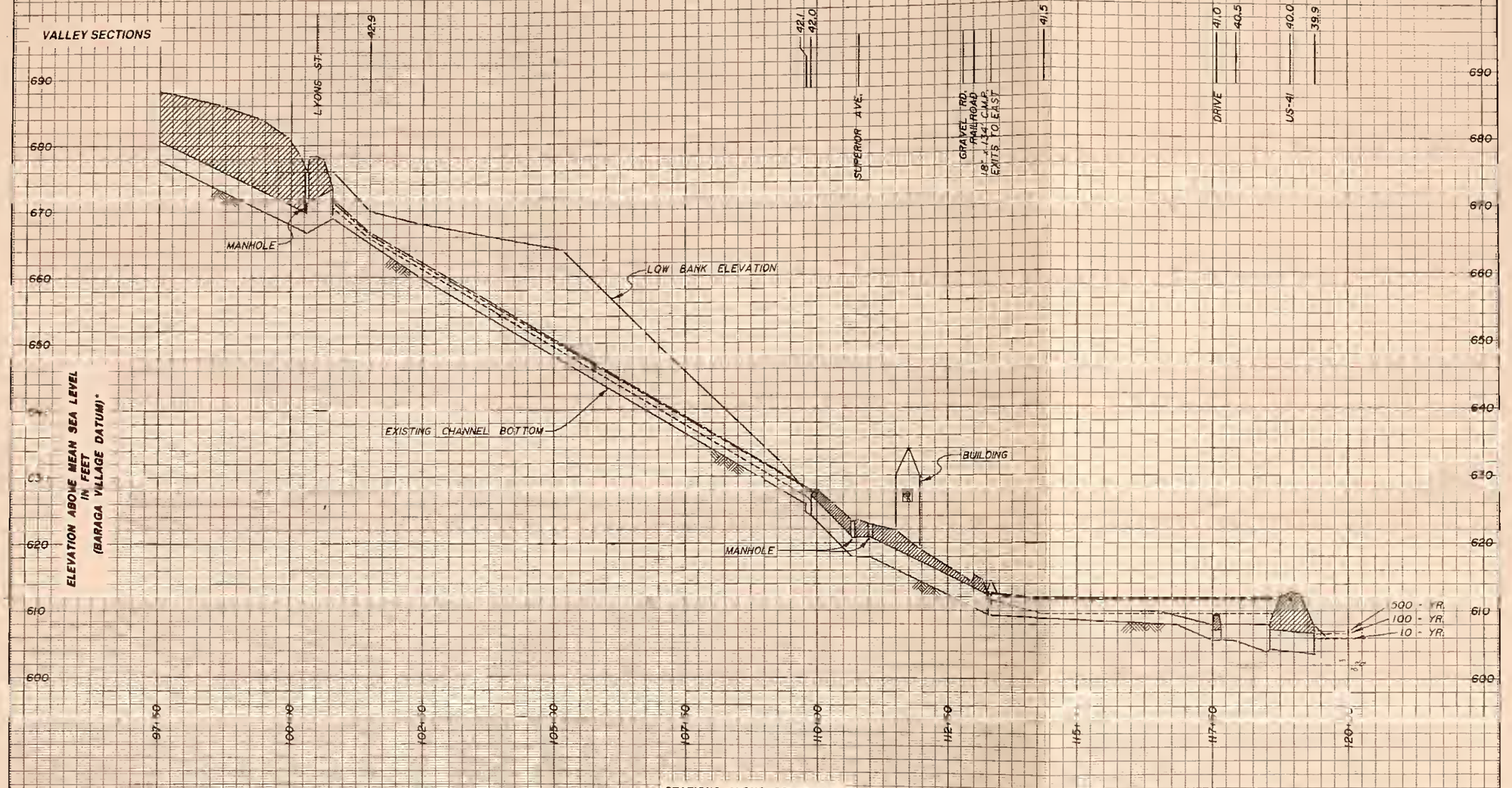
VALLEY SECTIONS



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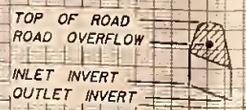

CENTER DRAIN
HIGH WATER PROFILES
BARAGA VILLAGE
FLOOD PLAIN MANAGEMENT STUDY
BARAGA COUNTY, MICHIGAN

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed	Date	Approved By	
T. D. Bourdon	3-90	Title	
Drawn			
C. N. Wade, L. Wilson	3-90	Title	
Traced			
Checked		Sheet No	Drawing No
S. S. Davis, L. B. Hill	3-90	13 of 17	

NOTE:
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APPROXIMATE

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SHEET 13 OF 18

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BARAGA VILLAGE
FLOOD PLAIN MANAGEMENT STUDY
BARAGA COUNTY, MICHIGAN

FLOOD HAZARD AREA

BARAGA VILLAGE-CENTER DRAIN

JUNE 1990 1006200

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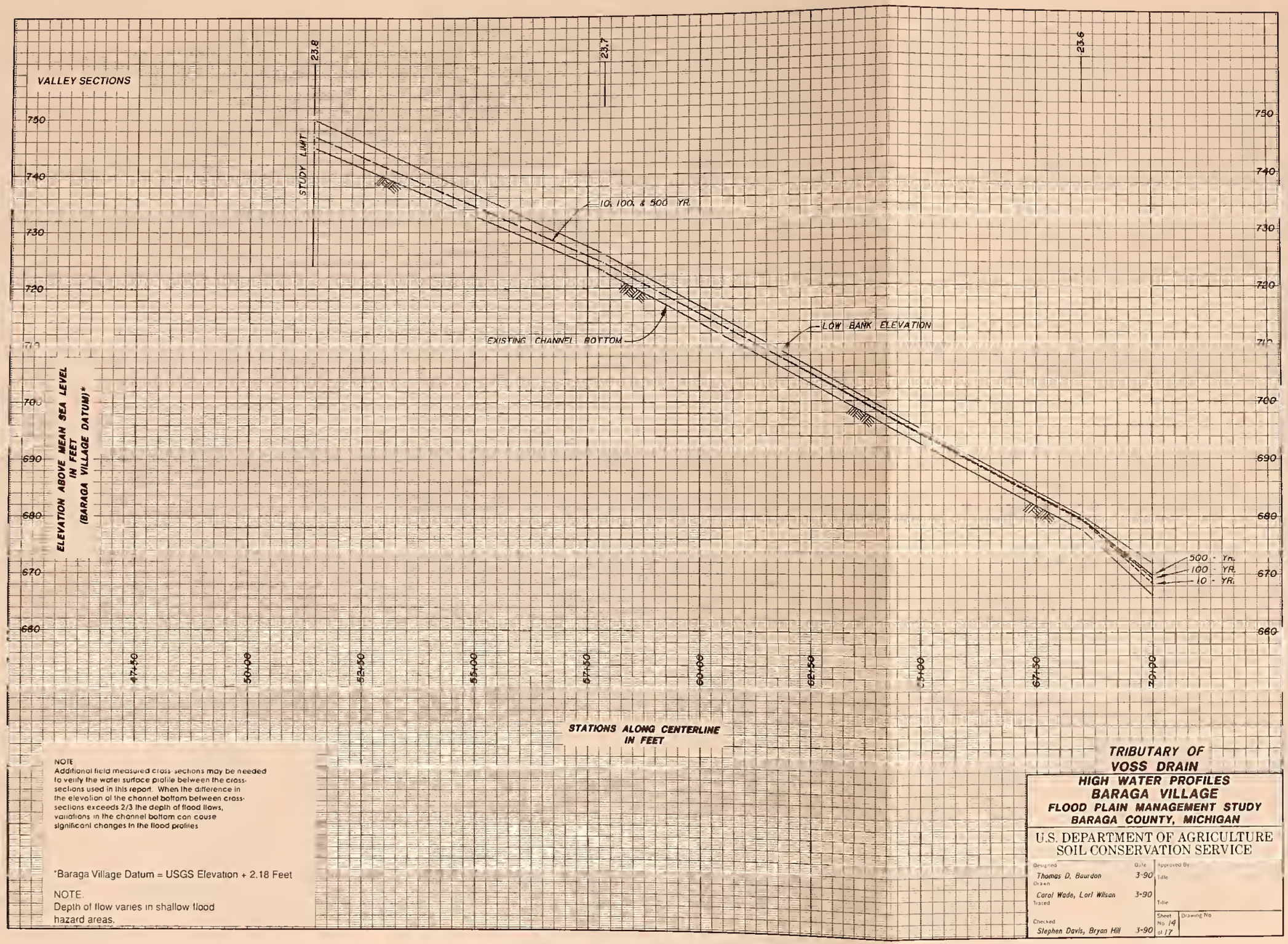

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NOTE.
Depth of flow varies in shallow flood hazard areas.

TRIBUTARY OF VOSS DRAIN
HIGH WATER PROFILES
BARAGA VILLAGE
FLOOD PLAIN MANAGEMENT STUDY
BARAGA COUNTY, MICHIGAN

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed	Date	Approved By	
Thomas D. Baurdon	3-90	Title	
Drawn			
Carol Wade, Lori Wilson	3-90	Title	
Traced			
Checked		Sheet No. 14 of 17	Drawing No.
Stephen Davis, Bryan Hill	3-90		

LEGEND

- 100 & 500 Year Flood Hazard Area
- Shallow Flood Hazard Area
- Stream Channel
- CS 45.1 — Valley Section Location
- Flow direction

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BARAGA VILLAGE
FLOOD PLAIN MANAGEMENT STUDY
BARAGA COUNTY, MICHIGAN

FLOOD HAZARD AREA

BARAGA VILLAGE-TRIBUTARY OF VOSS

SHEET 14 OF 18

JUNE 1990 100&200

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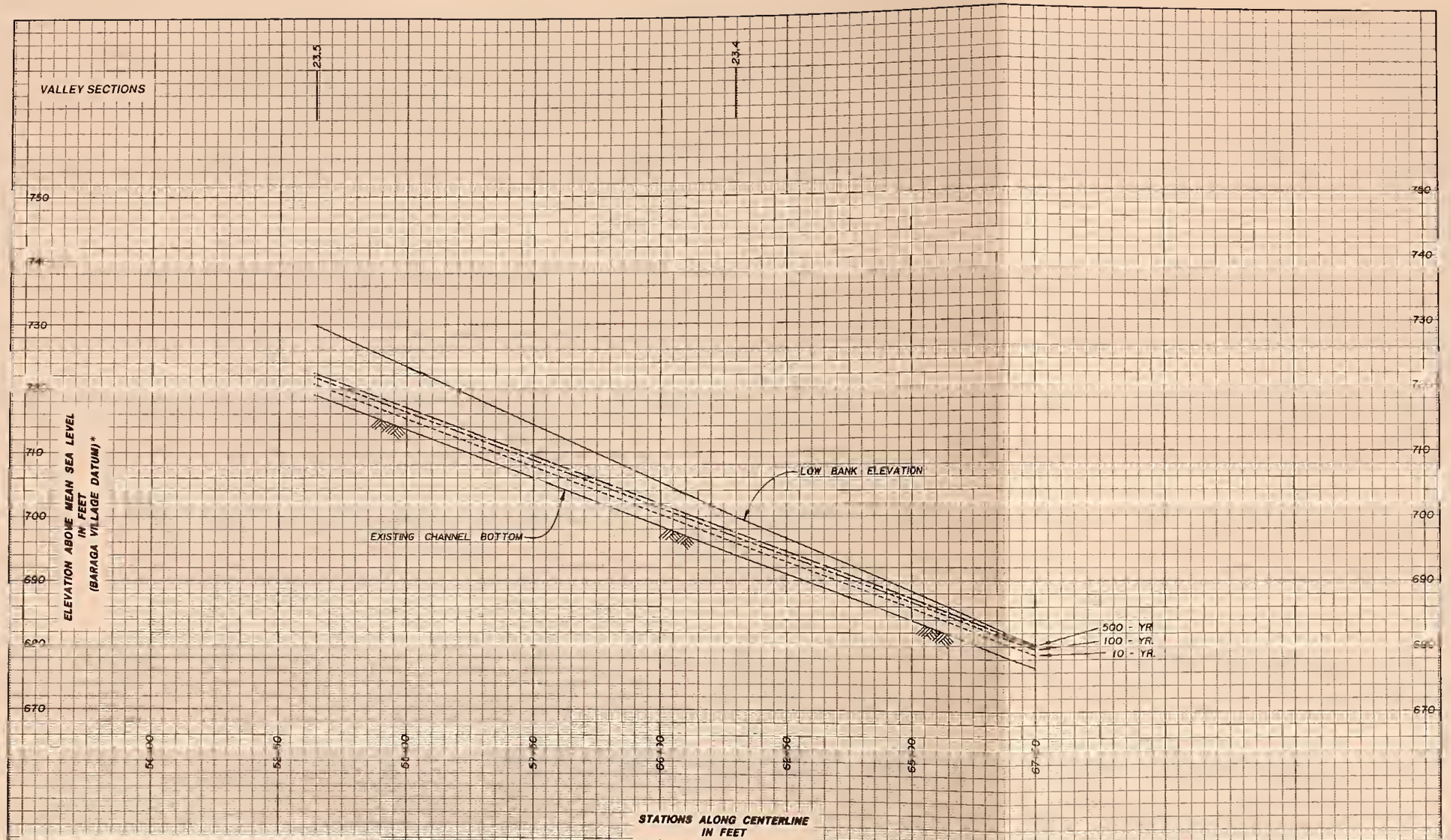
VALLEY SECTIONS



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VOSS DRAIN
HIGH WATER PROFILES
BARAGA VILLAGE
FLOOD PLAIN MANAGEMENT STUDY
BARAGA COUNTY, MICHIGAN

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed	T. D. Bourdon	Date 3-90	Approved By
Drawn	C. N. Wade, L. Wilson	3-90	Title
Traced			Title
Checked	S. S. Davis, L. B. Hill	3-90	Sheet No. 15 of 17 — Drawing No.

LEGEND

- 100 & 500 Year Flood Hazard Area
- Shallow Flood Hazard Area
- Stream Channel
- CS 45.1 — Valley Section Location
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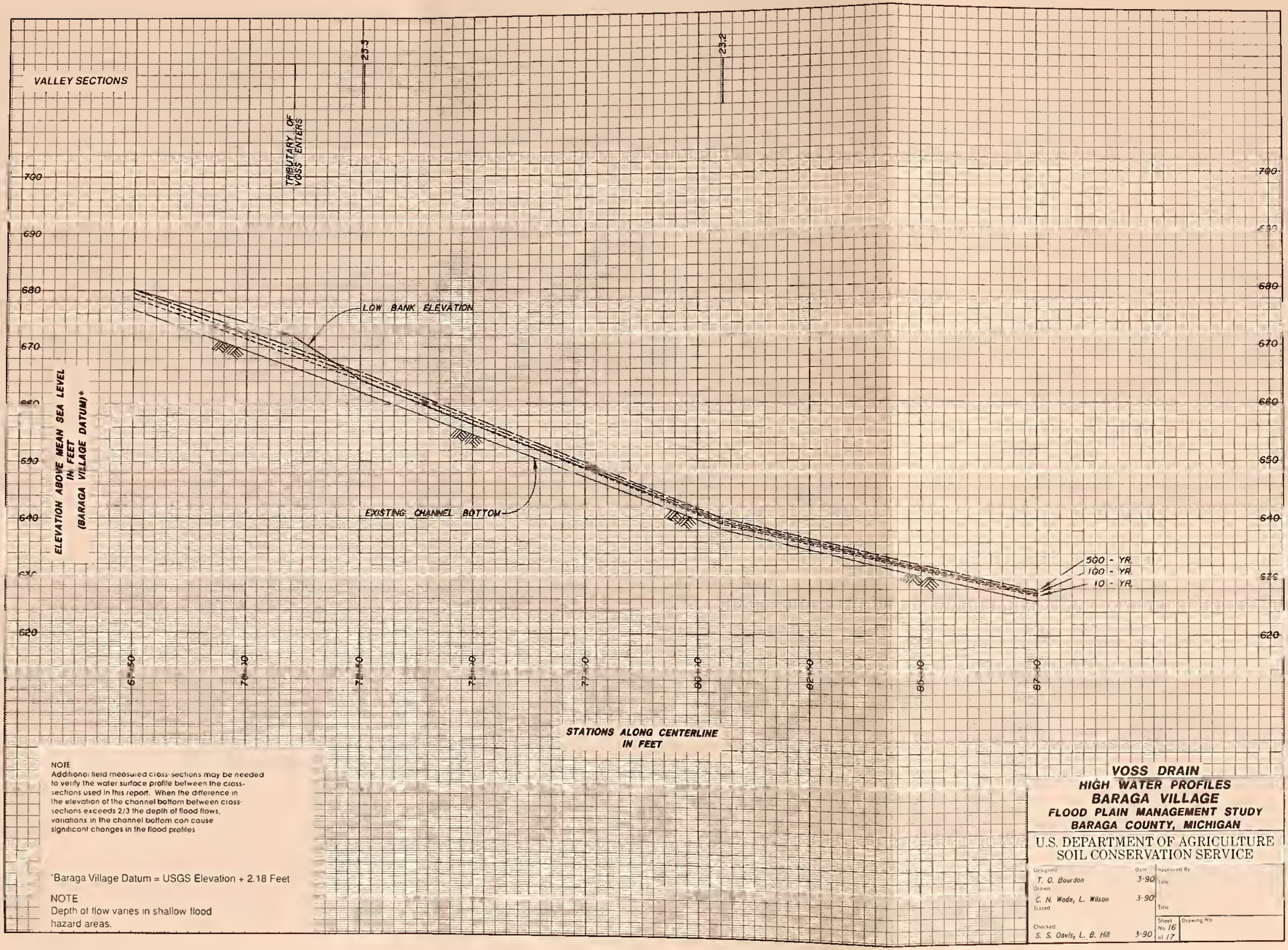
SOIL CONSERVATION SERVICE
BARAGA VILLAGE
FLOOD PLAIN MANAGEMENT STUDY
BARAGA COUNTY, MICHIGAN

FLOOD HAZARD AREA

BARAGA VILLAGE-VOSS DRAIN

SHEET 15 OF 18

JUNE 1990 1006200



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VOSS DRAIN
HIGH WATER PROFILES
BARAGA VILLAGE
FLOOD PLAIN MANAGEMENT STUDY
BARAGA COUNTY, MICHIGAN

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed	Date	Approved By	
T. O. Bourdon	3-90	Title	
Drawn			
C. N. Wade, L. Wilson	3-90	Title	
Traced			
Checked		Sheet No 16 of 17	Drawing No
S. S. Davis, L. B. Hill	3-90		

LEGEND

- 100 & 500 Year Flood Hazard Area
- Shallow Flood Hazard Area
- Stream Channel
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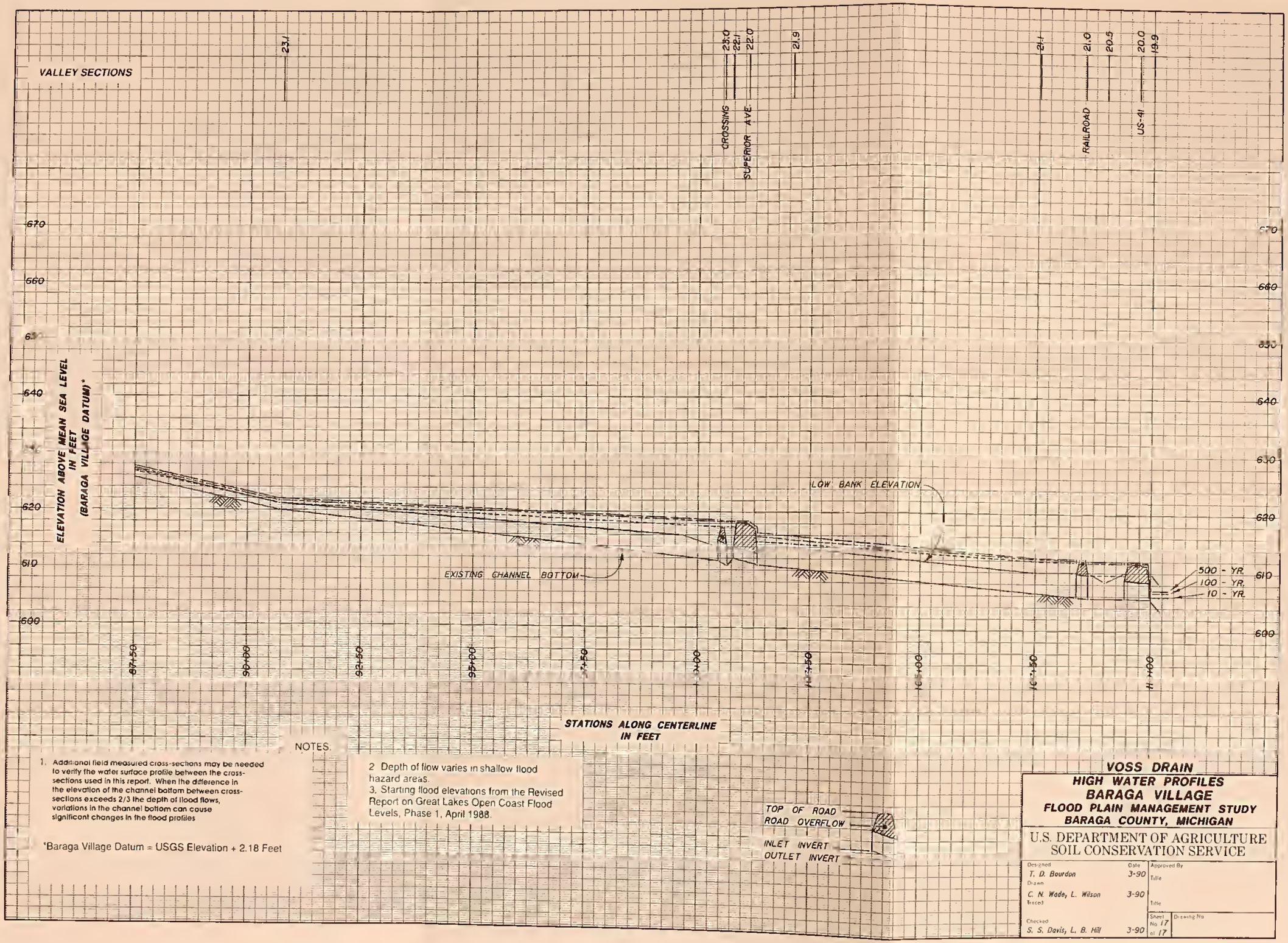
BARAGA VILLAGE
FLOOD PLAIN MANAGEMENT STUDY
BARAGA COUNTY, MICHIGAN

FLOOD HAZARD AREA

BARAGA VILLAGE-VOSS DRAIN

SHEET 16 OF 18

JUNE 1990 1006200



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VOSS DRAIN
HIGH WATER PROFILES
BARAGA VILLAGE
FLOOD PLAIN MANAGEMENT STUDY
BARAGA COUNTY, MICHIGAN

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed	T. D. Bourdon	Date 3-90	Approved By
Drawn	C. N. Wade, L. Wilson	3-90	Title
Traced			Title
Checked	S. S. Davis, L. B. Hill	3-90	Sheet No. 17 of 17 — Drawing No.

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LEGEND

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- Stream Channel
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FLOOD PLAIN MANAGEMENT STUDY
BARAGA COUNTY, MICHIGAN

FLOOD HAZARD AREA

BARAGA VILLAGE-VOSS DRAIN

SHEET 17 OF 18

JUNE 1990 1086200

LEGEND

- 100 & 500 Year Flood Hazard Area
- Shallow Flood Hazard Area
- Stream Channel
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APPROXIMATE

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FLOOD PLAIN MANAGEMENT STUDY
BARAGA COUNTY, MICHIGAN

SHEET 18 OF 18

FLOOD HAZARD AREA

BARAGA VILLAGE

JUNE 1990 1006200

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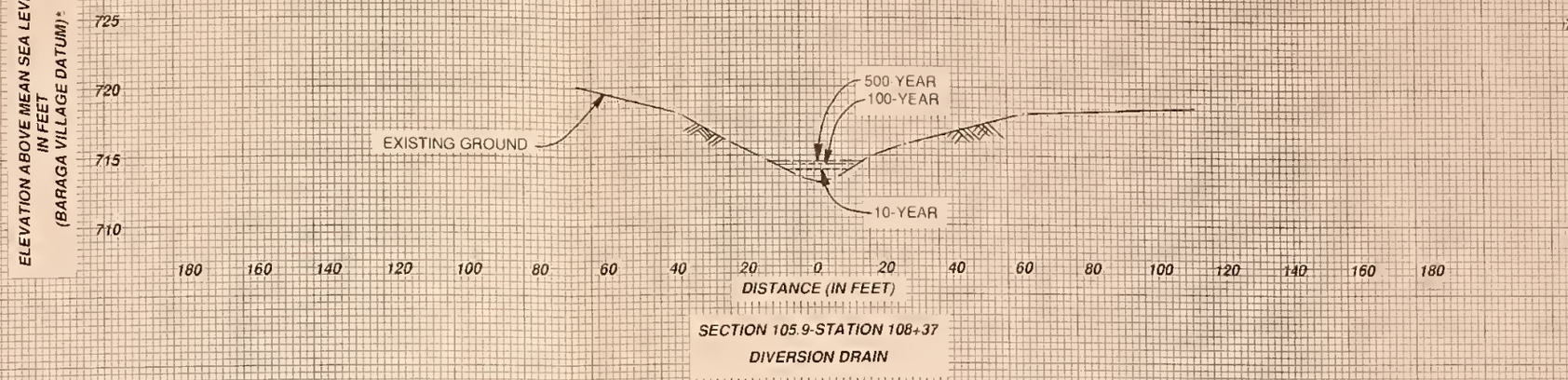
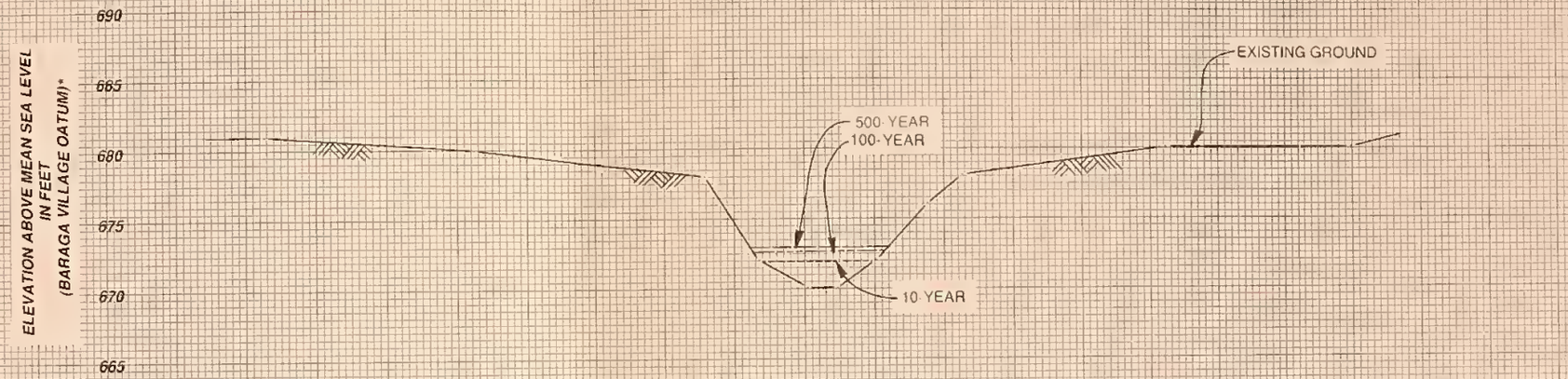
APPENDIX B



SECTION 105.9-STATION 108+37
DIVERSION DRAIN



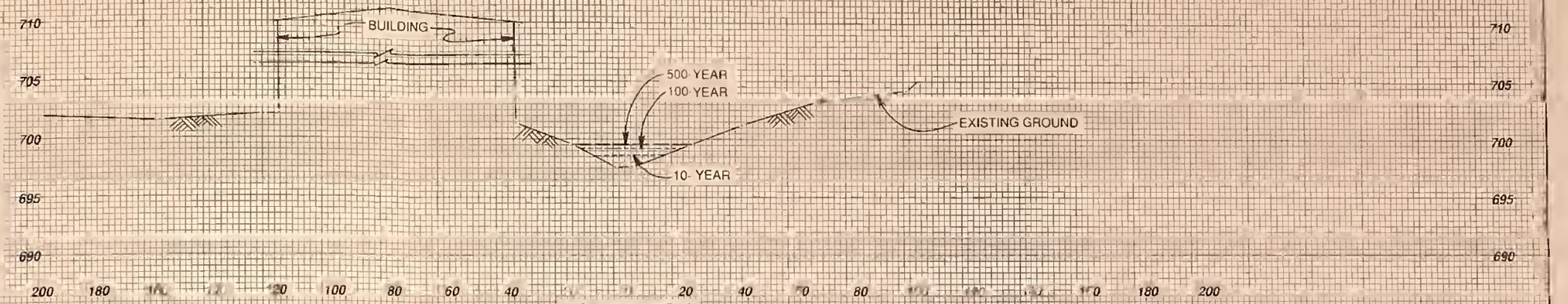
SECTION 71.5-STATION 112+35
NORTH DRAIN

*Baraga Village Datum = USGS Elevation + 2.18 Feet

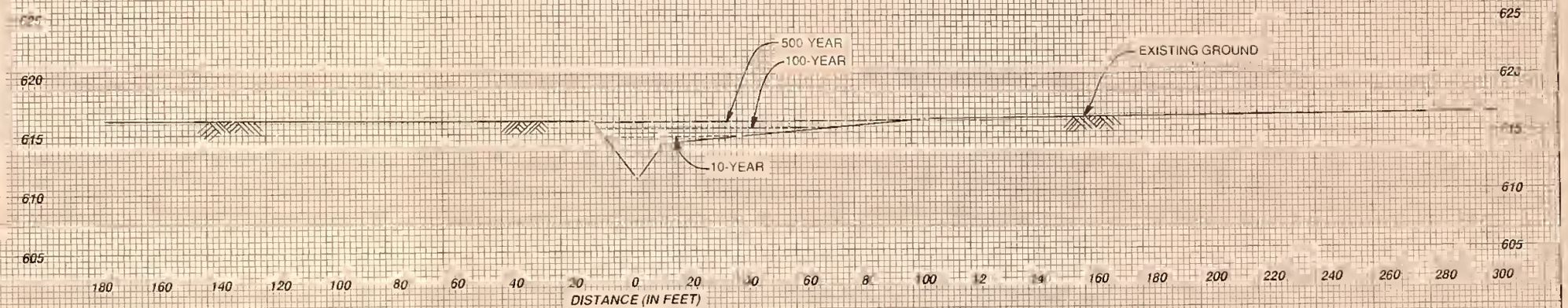
TYPICAL VALLEY SECTIONS
BARAGA VILLAGE
FLOOD PLAIN MANAGEMENT STUDY
BARAGA COUNTY, MICHIGAN

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed	Date	Approved By
T.D. Bourdon	3-90	Title
Drawn		
C.N. Wade	3-90	Title
Traced		
Checked		Sheet No. 1 of 2
S.S. Davis, L.B. Hill	3-90	Drawing No.



SECTION 45.7-STATION 88+90
CENTER DRAIN



SECTION 21.9-STATION 102+08
VOSS DRAIN

*Baraga Village Datum = USGS Elevation + 2.18 Feet

TYPICAL VALLEY SECTIONS
BARAGA VILLAGE
FLOOD PLAIN MANAGEMENT STUDY
BARAGA COUNTY, MICHIGAN

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed	Date	Approved By
T.D. Bourdon	3-90	Title
Drawn		
C.N. Wade	3-90	Title
Traced		
Checked		Sheet No. 2 of 2
S.S. Davis, L. B. Hill	3-90	Drawing No.

APPENDIX C

TABLE 3 - FLOOD DISCHARGES
VOSS DRAIN
BARAGA VILLAGE FLOOD PLAIN MANAGEMENT STUDY

Location	TR-20 Sec.	From WSP-2 Sec.	To WSP-2 Sec.	Drainage Area	Estimated Peak Discharges 10-Yr.	50-Yr.	100-Yr.	500-Yr.
				Sq. Miles	-Cubic Feet Per Second-			
Tributary								
To Upper End of Tributary	010	23.80	23.7	0.27	57	57	57	57
To Lower End of Tributary	013	23.60	23.6	0.30	62	78	81	94
Main								
To Upper End of Main	006	23.50	23.5	0.95	59	158	195	324
To Confluence of Tributary	008	23.40	23.4	1.06	66	174	215	355
To Superior Avenue	014	23.30	23.1	1.36	125	235	277	419
To US-41	017	23.05	20.5	1.56	125	255	301	458
Structure #1 1/	025	-	-	2.67	245	636	774	1,195
Str. #1		-	-	-	201	371	512	1,195

1/ Structure #1 is the low area above US-41 that extends from M-38 to the junction of US-41 and Superior Avenue.

TABLE 3 - FLOOD DISCHARGES
CENTER DRAIN
BARAGA VILLAGE FLOOD PLAIN MANAGEMENT STUDY

Location	TR-20 Sec.	From WSP-2 Sec.	To WSP-2 Sec.	Drainage Area	Estimated Peak Discharges 10-Yr.	50-Yr.	100-Yr.	500-Yr.
				Sq. Miles	-Cubic Feet Per Second-			
To Bear Town Road	002	50.1	49.95	0.25	32	93	117	204
To M-38	005	49.9	49.20	0.33	47	109	127	209
To McGillan Street	006	49.1	45.95	0.33	51	187	231	381
To School Tube	010	45.9	42.95	0.38	52	130	150	219
To Superior Avenue	012	42.9	42.00	0.38	23	58	63	81

TABLE 3 - FLOOD DISCHARGES
NORTH DRAIN
BARAGA VILLAGE FLOOD PLAIN MANAGEMENT STUDY

Location	TR-20 Sec.	From WSP-2 Sec.	To WSP-2 Sec.	Drainage Area	Estimated Peak Discharges 10-Yr.	50-Yr.	100-Yr.	500-Yr.
				Sq. Miles	-Cubic Feet Per Second-			
To Bear Town Road	003	74.1	73.9	0.05	4	10	12	16
To CS73.4 @ Sta. 62+20	006	73.6	73.4	0.18	28	71	87	138
To McGillan Street	008	73.1	72.9	0.23	33	84	101	161
To CS72.5 @ Sta. 95+90	009	72.5	72.5	0.23	50	121	148	238
To Main Street	012	72.1	70.6	0.41	145	274	317	460
To Keweenaw Bay	013	70.5	69.9	0.41	146	167	167	167
Structure #2 1/	018	-	-	0.57	73	210	265	451
	Str. #2	-	-	-	62	95	112	293

1/ Structure #2 is the low area above US-41 that extends approximately 2,700 feet north of M-38.

TABLE 3 - FLOOD DISCHARGES
DIVERSION DRAIN
BARAGA VILLAGE FLOOD PLAIN MANAGEMENT STUDY

Location	TR-20 Sec.	From WSP-2 Sec.	To WSP-2 Sec.	Drainage Area	Estimated Peak Discharges 10-Yr.	50-Yr.	100-Yr.	500-Yr.
				Sq. Miles	-Cubic Feet Per Second-			
From City Limits to Spruce Street	005	108.5	107.9	0.39	33	83	101	163
To Lyons Street	006	107.1	106.0	0.39	7	17	19	26
To Main Street	009	105.9	104.8	0.47	24	46	53	76
To Industrial Park Road	012	104.1	103.2	0.90	66	144	171	261
To Keweenaw Bay 1/	Str. #3	103.1	99.9	1.72	19	28	32	43

1/ The swamp above Industrial Park Road is a detention area (Structure #3).

TABLE 4 - FLOOD ELEVATIONS AT SECTIONS 1/
BARAGA VILLAGE FLOOD PLAIN MANAGEMENT STUDY

DIVERSION DRAIN

Location	Section 2/	Station	10-Year	50-Year	100-Year	500-Year
Keweenaw Bay			605.9	606.4	606.6	607.0
	99.9	173+40	605.9	606.4	606.6	607.0
US-41	100.0 D	170+94	605.9	606.4	606.6	607.0
	100.0 U	170+18	606.0	606.5	606.7	607.1
	100.5	169+67	606.0	606.5	606.7	607.1
Railroad	101.0 D	166+68	608.4	608.5	608.6	608.9
Crossing	101.0 U	166+20	610.3	610.7	610.9	611.2
	101.5	165+14	613.0	613.1	613.2	613.4
Superior	102.0 D	163+82	614.4	614.6	614.7	614.8
Avenue	102.0 U	163+12	615.5	615.8	616.1	616.6
	102.5	159+16	617.2	617.5	617.6	617.9
Industrial	103.0 D	155+52	618.0	618.3	618.4	618.7
Park Road	103.0 U	154+26	618.9	619.4	619.6	620.0
	103.1	151+66	618.9	619.4	619.6	620.0
	103.2	149+00	621.8	622.7	622.9	623.5
	103.3	145+72	634.3	635.1	635.3	635.9
	103.4	144+00	641.4	642.2	642.4	643.0
	103.6	138+00	646.2	647.1	647.3	647.7
	103.7	132+97	665.1	665.5	665.6	666.0
	103.9	124+98	682.7	683.1	683.2	683.6
Main Street	104.0 D	123+31	686.2	686.5	686.7	687.0
	104.0 U	122+36	690.0	690.1	690.2	690.3
	104.1	121+58	690.1	690.3	690.4	690.6
	104.8	114+30	703.8	704.1	704.2	704.3
	104.9	113+57	704.2	704.6	704.7	704.9
Crossing N of	105.0 D	112+83	706.9	707.5	707.6	707.7
Senior Center	105.0 U	112+11	710.0	710.1	710.2	710.3
	105.1	111+00	710.2	710.4	710.5	710.6
	105.9	108+37	713.8	714.1	714.2	714.4
Lyons Street	106.0 D	107+88	713.8	714.1	714.2	714.4
	106.0 U	107+26	714.2	715.3	715.5	715.9
	106.1	106+47	714.5	715.3	715.5	715.9
	106.9	99+41	716.5	716.6	716.7	716.8

1/ Elevations based on Baraga Village Datum.
Baraga Village Datum = USGS Elevation + 2.18 feet.

2/ U = Upstream side of crossing.
D = Downstream side of crossing.

TABLE 4 - FLOOD ELEVATIONS AT SECTIONS 1/
BARAGA VILLAGE FLOOD PLAIN MANAGEMENT STUDY

DIVERSION DRAIN - CONTINUED

Location	Section 2/	Station	10-Year	50-Year	100-Year	500-Year
Spruce Street	107.0 D	99+11	716.5	716.6	716.7	716.8
	107.0 U	98+51	717.1	717.8	718.0	718.3
	107.1	98+11	717.6	718.1	718.3	718.5
	107.9	91+07	732.1	732.6	732.7	733.0
McGillan Street	108.0 D	90+67	733.3	733.7	733.8	734.1
	108.0 U	90+07	735.5	740.5	740.8	741.4
	108.1	87+97	742.5	743.0	743.1	743.5
	108.5	80+87	764.4	764.7	764.8	765.0

1/ Elevations based on Baraga Village Datum.
Baraga Village Datum = USGS Elevation + 2.18 feet.

2/ U = Upstream side of crossing.
D = Downstream side of crossing.

TABLE 4 - FLOOD ELEVATIONS AT SECTIONS 1/
BARAGA VILLAGE FLOOD PLAIN MANAGEMENT STUDY

NORTH DRAIN

Location	Section 2/	Station	10-Year	50-Year	100-Year	500-Year
Keweenaw Bay			605.9	606.4	606.6	607.0
	69.9	130+00	605.9	606.4	606.6	607.0
Driveway	70.0 D	129+50	606.2	606.6	606.7	607.1
	70.0 U	128+36	611.5	612.4	612.5	612.6
	70.5	128+00	611.5	612.4	612.5	612.6
Main Street	71.0 D	127+51	611.5	612.4	612.5	612.6
Through US-41	71.0 U	122+14	623.0	627.4	627.7	628.2
	71.1	121+30	624.2	627.4	627.8	628.3
	71.4	115+05	661.7	662.2	662.4	662.8
	71.5	112+35	671.9	672.4	672.6	672.9
	71.9	106+80	685.2	685.8	685.9	686.3
Lyons Street	72.0 D	105+00	687.7	688.4	688.6	689.0
	72.0 U	104+60	689.5	689.7	689.8	690.0
	72.1	103+60	689.8	690.3	690.4	690.7
	72.5	95+90	705.9	706.1	706.2	706.3
	72.9	91+30	717.8	718.1	718.2	718.3
McGillan	73.0 D	90+30	719.4	719.5	719.6	720.0
Street	73.0 U	89+90	724.1	724.3	724.4	724.5
	73.1	88+90	725.6	726.3	726.5	726.9
	73.4	62+20	750.5	751.0	751.1	751.4
	73.6	67+40	784.7	785.1	785.2	785.5
	73.9	57+10	814.9	815.0	815.1	815.2
Bear Town Road	74.0 D	56+12	817.8	817.9	818.0	818.1
	74.0 U	55+48	818.8	819.6	819.8	820.1

1/ Elevations based on Baraga Village Datum.
Baraga Village Datum = USGS Elevation + 2.18 feet.

2/ U = Upstream side of crossing.
D = Downstream side of crossing.

TABLE 4 - FLOOD ELEVATIONS AT SECTIONS 1/
BARAGA VILLAGE FLOOD PLAIN MANAGEMENT STUDY

CENTER DRAIN

Location	Section 2/	Station	10-Year	50-Year	100-Year	500-Year
Keweenaw Bay			605.9	606.4	606.6	607.0
	39.9	119+40	605.9	606.4	606.6	607.0
US-41	40.0 D	119+36	605.9	606.4	606.6	607.0
	40.0 U	118+56	609.6	611.4	611.7	611.9
	40.5	117+93	609.6	611.4	611.7	611.9
Drive Crossing	41.0 D	117+66	609.6	611.4	611.7	611.9
	41.0 U	117+50	609.6	611.4	611.7	611.9
	41.5	114+35	609.6	611.4	611.7	611.9
Superior	42.0 D	113+29	611.7	612.4	612.5	612.6
Avenue	42.0 U	109+88	626.3	627.8	627.9	628.0
	42.1	109+80	627.0	628.1	628.2	628.3
	42.9	101+50	665.9	666.4	666.5	666.8
School Tube	44.0 D	100+79	670.4	671.0	671.3	671.7
	44.0 U	96+15	687.8	689.8	689.9	690.2
	44.5	93+40	689.7	691.4	691.5	692.0
Footbridge	45.0 D	93+05	690.9	692.1	692.4	693.1
	45.0 U	92+95	691.7	693.4	693.7	694.6
	45.1	91+70	693.3	693.9	694.1	694.7
	45.7	88+90	698.5	699.0	699.1	699.4
	45.9	86+90	703.2	703.8	703.9	704.3
McGillan	46.0 D	86+45	703.5	704.6	704.8	705.5
Street	46.0 U	85+65	708.1	709.7	709.8	710.3
	46.5	84+90	708.3	709.8	710.0	710.5
Drive Crossing	47.0 D	83+11	711.3	712.5	712.7	713.2
	47.0 U	82+91	714.7	716.2	716.3	716.7
	47.5	82+50	714.7	716.2	716.3	716.7
Drive Crossing	48.0 D	82+08	714.7	716.3	716.4	716.8
	48.0 U	81+78	717.6	718.5	718.6	719.0
	48.5	81+20	717.6	718.5	718.7	719.1

1/ Elevations based on Baraga Village Datum.
Baraga Village Datum = USGS Elevation + 2.18 feet.

2/ U = Upstream side of crossing.
D = Downstream side of crossing.

TABLE 4 - FLOOD ELEVATIONS AT SECTIONS 1/
BARAGA VILLAGE FLOOD PLAIN MANAGEMENT STUDY

CENTER DRAIN - CONTINUED

Location	Section 2/	Station	10-Year	50-Year	100-Year	500-Year
M-38	49.0 D	80+75	717.7	718.7	718.9	719.4
	49.0 U	79+78	720.7	723.7	723.9	724.4
	49.1	79+20	722.5	724.7	725.1	726.2
	49.2	78+20	726.9	727.9	728.2	728.9
	49.4	71+00	741.4	741.8	741.9	742.3
	49.6	62+50	761.7	762.2	762.3	762.7
	49.7	61+00	771.5	771.9	772.0	772.3
	49.8	57+10	777.8	778.2	778.3	778.8
	49.9	55+00	786.6	787.0	787.1	787.4
Bear Town Road	50.0 D	54+37	788.2	788.7	789.0	789.3
	50.0 U	53+63	791.3	794.5	796.0	796.6

1/ Elevations based on Baraga Village Datum.
Baraga Village Datum = USGS Elevation + 2.18 feet.

2/ U = Upstream side of crossing.
D = Downstream side of crossing.

TABLE 4 - FLOOD ELEVATIONS AT SECTIONS 1/
BARAGA VILLAGE FLOOD PLAIN MANAGEMENT STUDY

VOSS DRAIN

Location	Section 2/	Station	10-Year	50-Year	100-Year	500-Year
Keweenaw Bay			605.9	606.4	606.6	607.0
	19.9	110+00	605.9	606.4	606.6	607.0
US-41	20.0 D	109+97	605.9	606.4	606.6	607.0
	20.0 U	109+43	609.6	611.4	611.7	611.9
	20.5	109+00	609.6	611.4	611.7	611.9
Rail Road	21.0 D	108+65	609.6	611.4	611.7	611.9
	21.0 U	108+40	611.8	612.1	612.2	612.3
	21.1	107+52	611.9	612.2	612.3	612.5
	21.9	102+08	614.6	615.2	615.3	615.9
Superior	22.0 D	101+33	614.9	615.6	615.8	616.4
Avenue	22.0 U	100+79	617.4	618.2	618.3	618.5
	22.1	100+74	617.4	618.2	618.3	618.5
Crossing	23.0 D	100+66	617.4	618.2	618.3	618.5
	23.0 U	100+46	617.5	618.3	618.4	618.6
	23.1	90+70	621.2	621.6	621.7	622.0
	23.2	80+54	639.0	639.5	639.6	640.0
	23.3	72+54	664.1	664.7	664.9	665.5
	23.4	61+47	695.9	696.6	696.9	697.5
	23.5	53+20	720.7	721.6	721.8	722.4
Tributary	23.6	68+50	679.3	679.5	679.5	679.5
Entering Voss	23.7	57+85	724.5	724.5	724.5	724.5
at Sta. 71+00	23.8	51+40	747.0	747.0	747.0	747.0
From NW						

1/ Elevations based on Baraga Village Datum.
Baraga Village Datum = USGS Elevation + 2.18 feet.

2/ U = Upstream side of crossing.
D = Downstream side of crossing.

APPENDIX D

INVESTIGATIONS AND ANALYSES 1/

Survey Procedures

Field surveys were made of bridges, roads, structures, channels and flood plains of the Baraga Village tributaries by the Soil Conservation Service with local assistance in May 1988 and completed in October 1988. Temporary bench marks based on Baraga Village datum were established using second order accuracy. Baraga Village Datum = USGS Elevation + 2.18 feet. Temporary bench marks are described in Appendix E of this Technical Report.

For the Baraga Village tributaries, 28 roads, bridges and structures were surveyed. Aerial photography flow in November 1988 was used as a base for the photo mosaic sheets used to delineate the flood plains. Two-foot interval contour maps prepared by Abrams Aerial Survey Corp. in 1988 were used to develop 67 valley cross-sections.

Hydrology and Hydraulics

Physical data were obtained from USGS topographic maps, soil survey maps, local topographic maps and aerial photographs, as well as on-site field inspections. The watershed boundary was determined from map studies and field checks. The watershed was divided into 25 sub-watershed areas for use in evaluating the runoff volumes. Drainage areas for the sub-watersheds were measured from USGS topographic maps. Times of concentration were calculated for the sub-watersheds using the Michigan Department of Natural Resources UD-21 method and Manning's formula. Each sub-watershed was evaluated for land use, cover and soils. Runoff curve numbers were calculated.

Channel flood routings to establish peak discharge-frequency relationships were made for the four tributaries using the PC version of the SCS TR-20 Hydrology Computer Program dated September 1, 1983. The Modified Attenuation-Kinematic (Att-Kin) method of routing through stream channels is used by this program. This method is derived from inflow-outflow hydrograph relationships. Elevation-storage-discharge relationships were developed for temporary flood water storage areas above US-41 and in the swamp upstream from Industrial Park Road. The TR-20 computer program uses these data and the Storage-Indication Method of evaluating the effect of the structures in reducing peak flood discharges.

Flows are being diverted from Diversion Drain into North Drain above Bear Town Road and above Spruce Street. Flows are also being diverted from North Drain into Center Drain above Bear Town Road. At the lower end of North Drain, flows are being diverted into low areas above US-41 north and south of M-38. In addition, flows are being diverted from Voss Drain (Sub-Area #5) into Center Drain. The crossing under M-38 west of the intersection of Bear Town Road and M-38 restricts flow into Voss Drain and, as a result, flood waters flow over the top of Bear Town Road and enter Center Drain. Also, flows are being diverted out of Center Drain above Lyons Street (see Section 10 of Technical Report for Diverts). As a result of these diverts, read discharge hydrographs were utilized to enter hydrographs into downstream watersheds.

1/ For detailed analysis of hydrology and hydraulics, see Baraga Village Technical Report Documentation, dated May 1990.

The TR-20 Flood Routing Schematics can be found in Part 10 of the Technical Report. Appendix C, Table 3 lists discharges obtained from the flood routings and Appendix C, Table 4 lists flood elevations at sections located in the study area.

Peak discharges (100-year floods) from the TR-20 Model for Sub-Areas #1, #2, #3 and #4 combined, in addition to Sub-Area #8, were verified using a procedure titled "The 1983 MDNR/USGS Peak Flow Regression". This regression uses general physical and geological characteristics to estimate peak flow. Comparison of this regression analysis with TR-20 Model showed a very good correlation for the sub-areas. The regression analysis was only 10 to 17 percent higher than the TR-20 flows.

Water surface profiles for the Baraga Village tributaries were developed using the SCS WSP-2 computer program. This program uses the step method of computation to solve the Bernoulli equation and the Bureau of Public Roads bridge loss analysis. Flood discharges determined from flood routings were used in the water surface profile program to develop high water profiles along the channel. Manning's "n" values were determined from field investigations of the channel and flood plain. Starting elevations at Keweenaw Bay were obtained from the Revised Report on Great Lakes Open Coast Flood Levels, Phase 1, prepared by the U.S. Corps of Engineers in April 1988.

Normal bridge and channel flow conditions were assumed in the hydraulic computations. No consideration was made for openings blocked by ice or other debris. Channel and flood plain flow characteristics may change due to vegetative growth, sedimentation, scour, debris accumulation, filling and encroachment. Computations for this study considered only those features in the flood plain at the time of the field surveys. Future flood plain developments and modifications, as well as changes in the upstream drainage areas and land use and cover, will require recomputation of water surface profiles. Also, this report does not consider the effects of a seiche.

Flood plain delineations were made on the two-foot contour maps and photomap sheets. Computed water surface elevations at surveyed sections and bridges were used to identify flood plain limits. Between sections, topographic map interpretations and field inspections were used to delineate the flood boundary lines. Shallow flood hazard areas are based on field observations, interviews, contour maps and field surveys. Depth of flow varies. Limits of flooding shown on the photomaps may vary from true ground location due to inherent aerial photographic displacement. High water profile elevations and detailed field surveys should be used to determine the extent or depth of flooding at any specific site.

The limits of the 500-year and 100-year floods were generally too close to delineate and are shown as the same line on the photomap sheets.

APPENDIX E

US DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

VICINITY MAP

LEGEND

- UNIMPROVED ROAD
- GRAVEL OR SIMILAR ROAD
- BITUMINOUS SURFACED ROAD
- PAVED ROAD
- UNITED STATES HIGHWAY (27)
- STATE HIGHWAY (13)
- RAILROAD (ANY NUMBER TRACKS) USED BY SINGLE OPERATING CO.
- BENCH MARK (TBM 1-46)
- WATERSHED BOUNDARY
- NARROW STREAM
- CIVIL TOWNSHIP BOUNDARY
- SECTION LINE
- UNINCORPORATED COMMUNITIES
- INCORPORATED CITY OR VILLAGE

FIGURE 3

BENCH MARK LOCATION MAP

Baraga Village

FLOOD PLAIN MANAGEMENT STUDY

BARAGA COUNTY, MICHIGAN

2400 1200 0 2400 4800

SCALE IN FEET
Approximate

BASE COMPILED FROM MICHIGAN COUNTY HIGHWAY MAP.

JUNE 1990 1006199-03

USDA SCS-NATIONAL CARTOGRAPHIC CENTER, FT WORTH TX 1991

BENCH MARK DESCRIPTIONS *

BARAGA VILLAGE

BARAGA COUNTY, MICHIGAN

BM U.S.C. & G.S. C 48 1934

Section 1, T50N, R34W - About 0.95 mile south along Duluth, South Shore and Atlantic Railway from the Station at Baraga, at the crossing of Baraga Business Route of U.S. Highway 41, 212 feet south-southwest of the center of the crossing, 61 feet west of the center line of the highway, 40 feet west-southwest of telephone pole 834, 28 feet southeast of the southeast rail of the track, 21 feet west of a fence line, 1 1/2 feet southwest of a white wooden witness post, 2 1/2 feet below the track and set in the top of a concrete post projecting 4 inches.

Elev. 618.108

TBM 1-8 (Book 1, pg. 8)

Section 27, T51N, R33W - Top of "x" in west top of cement retaining wall 8.0 feet south of north end post and 26 feet east of centerline of Main Street and 2,670 feet north of M-38. Retaining wall located in front of Tangen Mfg. Plant.

Elev. 691.05

TBM 1-31 (Book 1, pg. 31)

Section 33, T51N, R33W - Top of 1 inch diameter steel rod (south rod) protruding from east wall of concrete loading ramp on end of spur railroad line of Wisc. Central R.R. located approximately 150 feet northeast of Baraga National Guard Armory. Rod located 2.0 feet above ground and 7.1 feet north of south end of loading dock. This location is also 500.5 feet southwest of 3rd Street RR crossing and 23.5 feet west of main line of railroad.

Elev. 616.91

TBM 1-32A

Section 33, T51N, R33W - Top of 1/2 inch diameter bolt on Fire Hydrant (3.5 feet above ground) located 50 feet east of US-41 centerline and 900 feet southwest of intersection of US-41 and State Street in Baraga.

Elev. 613.28

- - - - - - - - - - - -

* Elevations based on Baraga Village Datum.
Baraga Village Datum = USGS Elevation + 2.18 feet.

TBM 1-32B

Section 34, T51N, R33W - Top of 1 inch nut on top of Fire Hydrant located 60 feet southeast of intersection of US-41 and M-38.

Elev. 615.41

TBM 1-33

Section 33, T51N, R33W - Top of west end of center of west concrete headwall of 3 foot high x 4 foot wide R/C box culvert under US-41 located 1,700 feet northeast of intersection of South Business Rte. US-41 and US-41 (orange paint spot).

Elev. 610.24

TBM 1-34

Section 27, T51N, R33W - Top of east rim of Michigan Bell Telephone steel manhole located 22 feet east of railroad and 100 feet northeast of intersection of Wisc. Central Railroad and centerline of Spruce Street in Baraga.

Elev. 614.87

TBM 1-35

Section 27, T51N, R33W - Top of 1 inch nut on top of Fire Hydrant located 27 feet east of Superior Street and approximately 250 feet northeast of south entrance to industrial park complex (Nature Nuggets Bldg.).

Elev. 624.4

TBM 1-38

Section 33, T51N, R33W - Top of top nut of Fire Hydrant located 66 feet southeast of intersection of Lyons Street and M-38 in Village of Baraga.

Elev. 689.53

TBM 1-40

Section 33, T51N, R33W - Top of west corner of 2.9 foot square concrete base of flagpole located 50 feet east of entrance to Baraga Area Schools. Also, located 12 feet north and 216 feet west of intersection of Lyons Street and Pennock Street.

Elev. 687.24

TBM 1-46

Section 33, T51N, R33W - Top center of west concrete headwall of 5 foot x 2 foot R/C box culvert under Superior Avenue (Bus. US-41) located approximately 2,200 feet northeast of intersection of S. Bus. US-41 and US-41.

Elev. 616.26

TBM 2-20 (Book 2, pg. 20)

Section 27, T51N, R33W - Top of "+" mark in "110+65 station" in top center of east R/C headwall of 5 foot x 5 foot R/C box culvert under US-41. Located approximately 3,200 feet northeast of intersection of US-41 and M-38, or 600 feet southwest of entrance road to Mich. DNR District Headquarters.

Elev. 609.76

TBM 2-25 (Book 2, pg. 25)

Section 27, T51N, R33W - Top of northeast corner of angle iron in flat top of 12 foot x 60 foot x 4.3 foot deep R/C storage tank located approximately 350 feet northeast of Nature Nuggets Bldg. in Baraga Industrial Park. Also, located approximately 700 feet directly west of intersection of Superior Avenue and North Industrial Park Entrance Road.

Elev. 632.27

TBM 2-27

Section 33, T51N, R33W - Top of northeast collar bolt (1.1 foot above ground) of Fire Hydrant located approximately 40 feet south of centerline of M-38 and 400 feet west of McGillan Street in Baraga.

Elev. 727.46

TBM 2-33

Section 29, T51N, R33W - Top of railroad spike in east base (1.3 feet above ground) of 10 inch electric pole located approximately 32 feet west and 2,688 feet north of intersection of M-38 and Bear Town Road.

Elev. 827.21

TBM 2-34

Section 29, T51N, R33W - Top of 20 penny spike in east side (1.7 feet above ground) of 10 inch electric pole located approximately 32 feet west and 120 feet north of intersection of Guy Road and Bear Town Road or 3,430 feet north of M-38 and Bear Town Road.

Elev. 841.40

The following TBMs are MDOT TBMs corrected to USC & GS DATUS then adjusted to Baraga Datum

TBM #43 MDOT (Book 2, pg. 27)

Section 33, T51N, R33W - Top of "x" on southeast collar bolt (1.6 feet above ground) of Fire Hydrant located 70 feet south and 42 feet east of intersection of M-38 and Bear Town Road.

Elev. 786.11

TBM #44 MDOT (Book 2, pg. 27)

Section 33, T51N, R33W - Top of "x" on south collar bolt (1.3 feet above ground) of Fire Hydrant located 60 feet south of M-38 and approximately 425 feet west of Baraga Village Water Storage Tank.

Elev. 764.50

TBM #46 MDOT (Book 1, pg. 38)

Section 28, T51N, R33W - Top of "x" on top of east collar bolt on Fire Hydrant located 81 feet northeast of intersection of M-38 and McGillan Street in Village of Baraga.

Elev. 712.12

APPENDIX F

GLOSSARY

BACKWATER--The resulting highwater surface upstream from a dam, bridge or other obstruction in a river channel or high stages in a receiving stream.

BRIDGE DECK--Elevation of road surface at the bridge.

BRIDGE LOW CLEARANCE--The lowest point of a bridge or other structure over or across a river, stream or water course that limits the opening through which water flows. This is referred to as "low steel" or "low chord". It often is higher than the low point of the roadway.

CHANNEL or WATER COURSE--An elongated depression either natural or man-made having a bed and well-defined banks varying in depth, width and length which gives direction to a current of water and is normally described as a creek, stream or riverbed.

CHANNEL BOTTOM--The lowest part of the stream channel (either in a constructed cross-section or a natural channel). Bottom elevations at a series of points along the length of a stream may be plotted and connected to provide a stream bottom profile.

CONFLUENCE--A flowing together or place of junction of two or more streams.

CROSS-SECTION or VALLEY SECTION--A graph showing the shape of the stream bed, banks and adjacent land on either side made by plotting elevations at measured distances along a line perpendicular to the flow of the stream.

DATUM--An assumed reference plane from which elevations and depths are measured such as from sea level.

ELEVATION-DISCHARGE RELATIONSHIP--The relationship between water surface elevation and rate of flow at a specified location for a range of flow rates.

FLOOD--A temporary overflow by a river, stream, ocean, lake or other body of land not normally covered by water. It does not include the ponding of surface water due to inadequate drainage such as within a development. It is characterized by damaging inundation, backwater effects of surcharging sewers and local drainage channels, and by unsanitary conditions within adjoining flooded habitated areas attributable to pollutants, debris and water table.

FLOOD CREST--The maximum stage or elevation reached by flood waters at a given location.

FLOOD FREQUENCY--A means of expressing the probability of flood occurrences as determined from a statistical analysis of representative stream flow or rainfall and runoff records. It is customary to estimate the frequency with which specific flood stages or discharges may be equaled or exceeded, rather than the frequency of an exact stage or discharge. Such estimates by strict definition are designated "exceedence frequence", but in practice the term "frequency" is used. The frequency of a particular stage or discharge is usually expressed as occurring once in a specified number of years.

10-YEAR FLOOD--A flood having a long-term average frequency of occurrence in the order of once in 10 years. It has a 10 percent chance of being equaled or exceeded in any given year.

50-YEAR FLOOD--A flood having a long-term average frequency of occurrence in the order of once in 50 years. It has a 2 percent chance of being equaled or exceeded in any given year.

100-YEAR FLOOD--A flood having a long-term average frequency of occurrence in the order of once in 100 years. It has a 1 percent chance of being equaled or exceeded in any given year. This flood is comparable to the "Intermediate Regional Flood" used by the U.S. Army Corps of Engineers.

500-YEAR FLOOD--A flood having a long-term average frequency of occurrence in the order of once in 500 years. It has a 0.2 percent chance of being equaled or exceeded in any given year.

FLOOD PEAK--The maximum instantaneous discharge or volume of flow in cubic feet per second passing a given location. It usually occurs at or near the time of the flood crest.

FLOOD PLAIN--The relatively flat area or low lands covered by flood waters originating with either the adjoining channel of a water course such as a river or stream, or a body of standing water such as an ocean or lake.

FLOOD PRONE AREA--Areas that experience ponding due to high water table soils and/or inadequate outlets.

FLOOD ROUTING--The process of determining progressively the timing and shape of a flood wave at successive points along a stream. This procedure is used to derive a downstream hydrograph from an upstream hydrograph. Local inflow and tributary hydrographs are considered.

FLOOD STAGE--The elevation at which overflow of the natural stream banks or body of water occurs.

FLOODWAY--The portion of the flood plain including the channel of the stream that is required for the conveyance of flood flow.

FLOODWAY FRINGE--The area of the flood plain lying outside the floodway which may be covered by flood waters originating from an adjoining river or stream.

HEAD LOSS--The effect of obstructions, such as narrow bridge openings, dams or buildings, that limit the area through which water must flow, raising the surface water upstream from the obstruction.

HEADWATER--The tributaries and upper reaches which are the sources of the stream.

HIGH WATER or FLOOD PROFILE--A graph showing the relationship of water surface elevation location along the stream. While it is drawn to show surface elevations for the crest of a specific flood, it may be prepared for conditions at any other given time or stage.

HYDRAULICS--The science of the laws governing the motion of water and their practical applications.

HYDROGRAPH--A graph denoting the discharge or stage of flow over a period of time.

HYDROLOGY--The science dealing with the occurrence and movement of water upon and beneath the land areas of the earth.

INUNDATION--The flooding or overflow of an area with water.

LEFT BANK--The bank of the left side of a river, stream or water course, looking downstream.

LOW GROUND--The highest elevation at a specific stream channel cross-section at which the flow in the stream can be contained in the channel without overflowing into adjacent overbank areas.

MANNING'S "n"--A coefficient of channel and overbank roughness used in Manning's open channel flow formula, commonly called a retardance factor.

REACH LENGTH--A longitudinal length of stream channel selected for use in hydraulic or other computations.

RIGHT BANK--The bank on the right side of the river, stream or water course, looking downstream.

ROAD OVERFLOW--The lowest elevation on a road profile in the vicinity of where the road and stream cross. It is the first point on the roadway inundated if overtopping of the road occurs during a storm.

RUNOFF--That part of precipitation, as well as any other flow contributions, which appears in surface streams of either perennial or intermittent form.

SEICHE--An oscillation of the surface of a lake or landlocked sea that varies in a period from a few minutes to several hours and is thought to be initiated chiefly by local variations in atmospheric pressure, aided in some instances by winds and tidal currents and that continues for a time after the inequalities of atmospheric pressures have disappeared.

TIME OF CONCENTRATION--Time required for water to flow from the most remote point of a watershed to the outlet or other point of reference.

WATERSHED--A drainage basin or area which collects runoff and transmits it, usually by means of streams and tributaries, to the outlet of the basin.

WATERSHED BOUNDARY--The divide separating one drainage basin from another.

APPENDIX G

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